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Patient Characteristics, Discharge Disposition, and Hospital Factors Associated with All cause 30-day Hospital Readmission for Total Joint Arthroplasty in 2014

Hamad Yahya Alzamanan
University of South Carolina

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By

Hamad Yahya Alzamanan

Bachelor of Science

Idaho State University at Pocatello, 2009

Master of Science

University of New Haven, 2011

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Accepted by:

Zaina Qureshi , Major Professor

Ronnie D Horner, Committee Member

Ibrahim Demir, Committee Member

Lianming Wang , Committee Member

Cheryl L. Addy, Vice Provost and Dean of the Graduate School

DEDICATION

For my son (Mohammed), so that I may provide every possible opportunity for you during your battle against Glioma, and to show you that anything is possible, no matter how long and hard it takes to achieve.

ACKNOWLEDGEMENTS

The path that led me to this achievement was not easy. A few bumps, dead ends, detours, and a big hill at the end. But I made it to the end. I credit my cheerleaders, and my obstinacy for getting me to the end.

First and foremost, I would like to express my sincerest gratitude to the members of my dissertation committee. Dr. Zaina Qureshi, my dissertation chair / boss / advisor / mentor, has taught me to think big, to be meticulous but logical at the same time, and she has always given me the latitude to do things my own way. She believed I could do this and never gave up on me. My sincere thanks also goes to Dr. Ronnie Horner, Dr. Ibrahim Demir, and Dr. Lianming Wang. I am grateful to all of you, and it has been my honor and privilege working with you all.

Last but not the least, I would like to thank my family: my wife, my parents and my brothers and sister who have provided me with moral and emotional support throughout my life.

ABSTRACT

Objective: Recent improvements in hospital care have come from a growing knowledge of factors that contribute to readmission. The objective of this work is to identify and describe the national readmission rate after Total Joint Arthroplasty, and to evaluate selected hospitals' and patients' factors for their association with the all-cause 30-day readmission rate after TJA in the United States in 2014.

Method: Retrospective analysis of 938,504 TJA acute care hospital discharge records was performed, using a nationally representative database that is dedicated to the study of hospital readmissions, and accounts for 51% of total US hospitalizations. Logistic regression models were used to analyze patient characteristics, discharge disposition, and hospital factors associated with all-cause 30-day hospital readmission.

Results: The national rate of 30-day readmissions after TJA was 4%. A patient's age, gender, type of insurance, discharge destination, and DRG severity were all significantly associated with readmission, at ($p < 0.0001$). Female patients had a 22% lower risk of readmission than the males. Patients who had Medicare as the primary payer had 34% higher risk, and those with Medicaid had a 74 % higher risk, while patients with other types of insurance, such as worker's compensation or other government programs, were at a 27% higher risk for readmission when compared to patients with commercial insurance. Patients discharged to a skilled nursing or intermediate care facility had a 61%

higher risk for hospital readmission, while those who were discharged to home health-care services had a 10% higher risk for readmission when compared to patients discharged to home with no further medical services. TJA patients discharged home tend to have the lowest rates of 30-day readmission. Additionally, patients who receive post-acute care services at home are less likely to be readmitted to the hospital compared with those who receive post-acute care at inpatient settings, such as skilled nursing or intermediate care facilities.

Discussion: Studying risk factors associated with hospital readmissions, potential interventions, and related measurements is important to create effective programs that improve patient clinical outcomes, and design fair adjusted payment incentives that favorably affect healthcare cost and quality of care. Adjusting risk to account for patient characteristics, hospital factors, and post-acute care is essential for designing provider incentives that reduce hospital readmission and avoid unintended consequences. Also, a stratification of patients can be used to identify those at higher risk of readmission so that a greater intensity of intervention can be used to avoid readmissions.

Key Words: Readmissions, Rehospitalizations, Total Joint Arthroplasty, Comprehensive Care for Joint Replacement Model (CJR), Care Transition.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACA ..... Affordable Care Act

ACS-NSQIP ..... American College of Surgeons National Surgical Quality Improvement

AHRQ ..... Agency for Healthcare Research and Quality

CJR..... Comprehensive Care for Joint Replacement Model

CMS..... Centers for Medicare and Medicaid Services

HCUP..... Healthcare Cost and Utilization Project

HCUP..... Healthcare Cost and Utilization Project

HRRP ..... Hospital Readmission Reduction Program

LOS..... Length of Hospital Stay

MedPAC..... Medicare Payment Advisory Commission

NRD..... Nationwide Readmissions Database

OA ..... Osteoarthritis

SID..... State Inpatient Databases

THA ..... Total Hip Arthroplasty

TJA..... Total Joint Arthroplasty

TKA..... Total Knee Arthroplasty

CHAPTER 1
INTRODUCTION

1.1 Overview.

In recent years, there has been a dramatic increase in the orthopedic surgical procedures performed in the United States, particularly joint arthroplasty. Between 2003 and 2012, knee arthroplasty and hip replacement were in the top five operating room procedures performed for adults aged 45 years and older, with an average annual increase of 2.9% for hip replacement, and a 4.9% increase for knee arthroplasty for all age groups, far outpacing the average annual population growth rate of 0.88% during the same 10-years period[1]. (Table 1.1) from the Healthcare Cost and Utilization Project (HCUP) statistical brief presents procedures with the greatest change in rate per 100,000 population between 2003 and 2012 (Steiner, Carol, Audrey, & Claudia, 2014). Five of the first six procedures were related to the musculoskeletal system.

Table 1.1 Operating room procedures with the greatest change in rate, 2003–2012.

Rank	Operating room procedure	Stays, n	Rate per 100,000 population			Average annual % change in rate, 2003–2012
		2003	2012	2003	2012	
	Procedure (greatest increase in rate)					
1	Gastrectomy, partial and total	26,900	74,100	9.3	23.6	10.9
2	Arthroplasty knee	421,700	700,100	145.4	223.0	4.9
3	Arthroplasty other than hip or knee	55,900	90,000	19.3	28.7	4.5
4	Partial excision bone	232,500	338,000	80.1	107.7	3.3
5	Spinal fusion	316,00	450,900	108.9	143.6	3.1
6	Hip replacement, total and partial	333,200	468,000	114.8	149.1	2.9

[1] https://data.worldbank.org/indicator/SP.POP.GROW?end=2012&locations=US&start=2003&view=chart

The growth in demand for joint arthroplasty is expected to continue to increase over the next twenty years; current projections estimate that; by 2030 the demand for total hip arthroplasties will grow by 174 percent, which equals 572,000 per year, while the demand for total knee arthroplasties will increase by 673 percent, which is 3.48 million procedures per year, nearly a 7-fold increase (S. Kurtz, Ong, Lau, Mowat, & Halpern, 2007). This increase will generate a significant expenditure in the American healthcare system; since 2005, the cost of TKA has risen more than 5 times, to $40.8 billion, and the cost of THA has risen more than 4 times, to $13.43 billion (S. M. Kurtz et al., 2007). Increase in demand coupling with this price tag makes TJA the single largest cost in the Medicare budget (Li, Lu, Wolf, Callaghan, & Cram, 2013).

The increase in joint replacement arthroplasty can be viewed as an indication of the success of this procedure in safely reducing pain and improving patient's quality of life. However, hospital readmission following TJA hospitalization has increased in the last 15 years. Cram and colleagues report an increase in 30-day all-cause readmission for Medicare population undergoing total hip arthroplasty from 5.9% to 8% between 1991 and 2008 (Cram et al., 2011), they also report an increase in the 30-day all-cause readmission rates from 4.2% to 5.0% after knee arthroplasty between 1991 and 2010 (Cram et al., 2012). The most recent report on the 30-day all-cause hospital readmission rate after TJA hospitalization is 4% (S. M. Kurtz et al., 2017b). Inadequate care transitions planning, bad communication , and delays in scheduling post care services are among the most common causes of preventable readmissions (Bisognano & Boutwell, 2009).

Hospital readmissions are difficult for patients and costly for hospitals. Hospital readmissions usually associated with poor outcomes for patients, payer, and provider. Higher rates of hospital readmission can reflect suboptimal quality of care during the index stay, and a lack of coordination among health care providers and patients in the transition to home or another post-discharge care setting. Health care providers have adopted a wide variety of strategies to lower hospital readmission but with mixed results (Dundon et al., 2016; King et al., 2017). Research suggests that, hospital readmission can be reduced through the adoption of quality initiatives, disease management programs, and by interventions that improve the transition between health care settings. However, the U.S healthcare prospective payment system fee-for-service has been insufficient to incentivize collaboration and coordination across care settings and between various health care providers.

Payers and policy makers are working cooperatively to find ways to improve the quality of patient care and lower health care spending. One indicator of inadequate quality that results in increased healthcare spending is the rate of readmissions to a hospital. Recently hospitals became responsible for what happens to the patient up to 90 days after discharge. Incentives in the form of payments and public recognition reward hospitals for reducing hospital readmissions. Starting in October 1st, 2012, the affordable Care Act (ACA) created new payment incentives with the Centers for Medicare and Medicaid Services'(CMS) Hospital Readmission Reduction Program (HRRP), which reduced payment to hospitals with higher-than-predicted risk adjusted readmission rates. All Medicare hospitals are included in this new payment policy with an exception to

hospitals that are providing primarily rehabilitation, psychiatric, long-term care, children care, critical care; also some cancer research centers are not included in this new payment policy ("Hospital Readmission Reduction Program," 2015). The HRRP policy exposes hospitals to financial risk with penalties that range from 1% to 3% of their aggregate payments in a single year based on their excess 30-day readmissions. A recent study of high-volume, urban tertiary orthopedic center has estimated that, their potential penalty from CMS could amount to over $6 million annually if their institution's all-cause risk-adjusted 30-day readmission rates exceeded the national mean (R. Carter Clement et al., 2014). However, the method used by CMS to calculate excess readmission rates does not adjust for factors such as socioeconomic status, case mix, or patient's admission or discharge disposition (to home vs, post-acute care facilities). HRRP targets acute care hospitals readmission rate within 30 days of discharge since this period is when discharged patients are most vulnerable to rehospitalization. Another payment model that imposes substantial financial risk at hospitals is the episode payment model such as Comprehensive Care for Joint Replacement Model (CJR) which holds hospitals financially responsible for the cost and quality of episodes of care delivered from the time of surgery through 90 days after discharge, thereby incentivizing increased care coordination between hospitals, physicians, and post-acute care providers. The model began on April 1, 2016 and will run through December 31, 2020. Policy makers are using a motivation tactic that has a combination of rewards and punishment to induce better performance.

Since more risk has been shifted to hospitals, they have begun developing strategies such as: enhanced patient education, post-discharge follow-up care, and increased coordination with post-acute providers to reduce readmissions. Hospitals have adopted interventions involving patient care plans and post-acute care coordination, aiming to engage patients, family members, and caregivers in meeting patient needs after discharged from hospital, provide information needed to help avoid readmission, planning post-acute care, open communications channels, and other interventions to reduce the risk of unnecessary hospital readmission. Appendix C contains some of the interventions designed by hospitals that show favorable results in reducing hospital readmission rate.

Studying risk factors associated with hospital readmissions, potential interventions, and related measurements is important to create effective programs that improve patient clinical outcomes, and design fair adjusted payment incentives that favorably affect healthcare cost and quality of care. Adjusting risk to account for patient characteristics, hospital factors, and post-acute care is essential for designing provider incentives that reduce hospital readmission and avoid unintended consequences.

1.2 Joint Osteoarthritis.

Osteoarthritis (OA) or degenerative joint disease is by far the most common form of arthritis which causes substantial physical and psychosocial disability in elderly population (Gabriel & Michaud, 2009; Guccione et al., 1994; Salaffi, Carotti, Stancati, & Grassi, 2005). The National Arthritis Data Workgroup studied the prevalence of Arthritis

conditions in the United States and estimated that approximately 27 million Americans aged 25 or older are affected by osteoarthritis, and the most commonly affected joints are knees, and hips (Lawrence et al., 2008). According to the Arthritis Foundation webpage, one in two adults will develop symptoms of knee OA during their lifetime, and one in four adults will develop symptoms of hip OA by the age of 80 (Arthritis, 2017). And as the baby-boomer generation ages, the number of people with arthritis and rheumatic conditions in the United States is expected to reach 67 million by the 2030 (Hootman & Helmick, 2006). Osteoarthritis is progressive chronic condition in which cartilage (the part that cushions the joint) wears down (Figure1.1) , and can lead to permanent functional disability, posing a serious health concern in affected patients ("Prevalence of disabilities and associated health conditions among adults—united states, 1999," 2001).

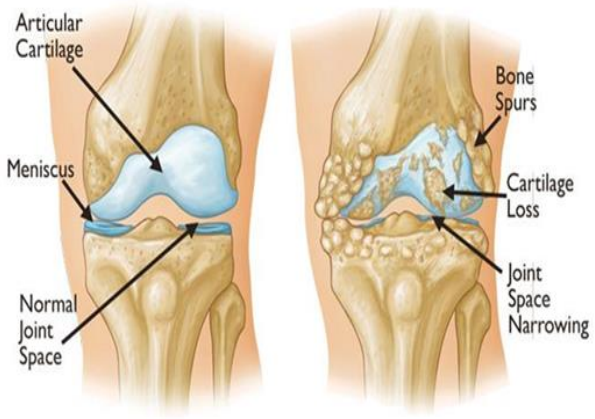


Figure 1.1 End-stage Osteoarthritis knee

Currently, the process underlying osteoarthritis cannot be reversed, but symptoms can usually be effectively managed. A combination of weight control, moderate regular physical activity and medication can alleviate osteoarthritis symptoms

(Macera, Hootman, & Sniezek, 2003). However, as osteoarthritis progresses, all joint structures will be affected, and conservative treatments might be ineffective to manage symptoms. In most cases, the best osteoarthritis treatment might be surgery to replace the affected joint, as the prosthetic implants, via the surgery, act as a substitute cushion for the damaged cartilage, thereby eliminating pain and restoring range of motion. Wide evidence indicates that, the majority of patients who have had a TJA procedure report improvement in pain and function (Callahan, Drake, Heck, & Dittus, 1994). A study by Hawker et al. estimated that 93.4% of all Medicare patients receiving knee replacements between 1985 and 1989 had a primary diagnosis of osteoarthritis (Hawker et al., 1998), which make Osteoarthritis the most common cause of TJA. The Agency for Healthcare Research and Quality (AHRQ) estimated that, $16.5 billion was spent in 2013 to treat patients with osteoarthritis, making osteoarthritis the second most expensive condition after Septicemia, accounting for about 4.3 percent of the aggregate costs for all hospitalizations is the U.S during the year of 2013.(Moore & Brian, 2016).

1.3 Joint Arthroplasty.

Total Joint Arthroplasty (TJA) is a common effective surgical procedure for end-stage hip and knee osteoarthritis aiming to relieve pain and improve the patient's joint function. During the procedure, surgeons cut away damaged bone and cartilage and replace them with an artificial joint made of metal alloys, high grade plastics and polymers as seen in figure 1.2 (American Academy of Orthopaedic Surgeons, 2018).

Hip arthroplasty technique was developed by the British Orthopedic surgeon Johan Charnley in 1960, and twelve years later the first generation of knee total condylar prostheses was introduced in 1972 by Insall and colleagues (Gomez & Morcuende, 2005; Scuderi, Scott, & Tchejeyan, 2001). Joint replacement was widely performed in the 1970s and 80s, In the last few decades, major improvements in surgical materials and techniques have greatly increased its efficacy , and it is now generally considered to be a physically beneficial and cost-effective treatment for end-stage Joints arthritis (Pivec, Johnson, Mears, & Mont, 2012).

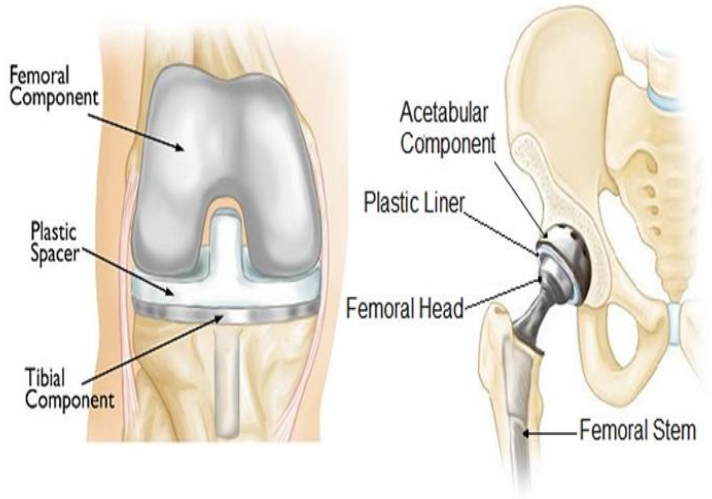


Figure 1.2 Implant as it fits into the joint

Several factors should be looked at before selecting a patient for joint arthroplasty, including age, comorbidities, and stage and anatomy of disease or joint damage. Contraindication for TJA may include active local or systemic infection, but other factors such as poor cardiovascular health , and neurological disease may also disqualify patient for TJA ("NIH Consensus Statement on total knee replacement," 2003).

Rehabilitation after TJA may take up to 12 months (Tribe et al., 2005), and outcomes after TJA varies according to patient demographics, health-related factors, and surgical factors (Parsons & Sonnabend, 2004). Reported rates of 30-day readmission rates after TJA have ranged from 4% to 8.5% based on the case complexity used to report these findings (K. J. Bozic et al., 2010; Cram et al., 2011). The vast majority of studies that investigate reasons for hospital readmission after TJA within 30-days of discharge have identified procedure-related complications such as infection, and dislocation of prosthetic joint to be the most common reasons for hospital readmission after TJA (Saucedo et al., 2014; Schairer, Vail, & Bozic, 2014). However, the quality and costs of care for hip and knee replacement surgeries vary greatly among providers. For instance, the rate of complications like infections or implant failures after surgery can be more than three times higher at some facilities than others. The cost of such procedures also varies; the average Medicare expenditure for the surgery, hospitalization, and recovery ranges from $16,500 to $33,000 across geographic areas (Cms.Gov, 2015).

Previous studies on the risk factors for readmission after TJA rate have reported patient-related factors such as: age, gender (female), body weight (obesity), and higher than average patient's length of hospital stay (LOS), to have a negative effect on the risk of 30-day readmission after TJA (Paxton et al., 2015). In addition, multiple studies have found that, hospital-related factors such as hospital procedure volume and nonprofit ownership were significant risk factors for readmission after TJA.(S. M. Kurtz et al., 2016a).

Recent improvements in TJA come from good understanding of the risk factors that influence readmission, and the need for a collaborative approach involving acute and post-acute care settings. The adoption of the quality initiatives such the ones that improve the transition between health care settings that enhance communication and patients' education already demonstrated reproducibly excellent results in reducing 30-day hospital readmission rate after TJA. Appendix A contains some of the interventions designed by hospitals to reduce hospital readmission rate after TJA.

1.4 Problem Statement.

Policy Interventions to lower hospital readmission and improve patient outcomes after TJA are constantly being introduced. In addition to the CMS HRRP that penalizes hospitals that have high TJA readmission rates, CMS announced new payment model, the Comprehensive Care for Joint Replacement (CJR) starting on April 1st, 2016 which enacts mandatory bundled payments for primary TJA in 67 geographic areas, where hospitals are held responsible for clinical outcomes and costs up to 90 days after surgery ensuring appropriate and high value post-acute care is more important than ever before. Previous studies on the effect of discharge destinations on the readmission rates after TJA were limited to patients discharged to inpatient rehabilitation sites such as skilled nurse facilities, or those discharged to home with care agencies; they did not address patients discharged to home without any form of post-acute care services. This lack of evidence is especially important in the case of the new bundled payments models that hold hospitals accountable for patient outcomes and cost of care up to 90 days after discharge

regardless of where the patient goes after care, placing increased emphasis on fast discharge of patients to the most appropriate destination, so they can minimize the use of unnecessary post-acute care services. Recently published work by Dundon et al, has demonstrated that, 20% decrease in the cost per episode of care, that was achieved by reducing discharge to inpatient rehabilitation from 44% to 28%, they also reported reduction on the 30-day readmission rate by 2% (Dundon et al., 2016). Our work will be using a large comprehensive dataset, the Nationwide Readmissions Database (NRD) a unique and powerful database designed by H-CUP to support various types of analyses of national readmission rates for all payers and the uninsured, allowing us to follow TJA patients after hospital discharge, including those discharged to home with no aftercare services, so that, we will be able to investigate the effect of all possible discharge destinations on the readmission rate after joint replacement procedures. Sending TJA patients directly home without any further care might be an optimal cost saving option when it's safe to do so.

TJA readmission rate may also be affected by other factors which can be related to patient, hospital, and/or post-acute care settings. It is good to know how much each factor contributes to readmission risk. The availability of a large dataset that includes detailed patient and hospital information will allow us to achieve better understanding of factors that influence hospital readmission after TJA; most of the previous work is limited to single institution datasets or focus only on one payor group such Medicare patients. This is particularly important in terms of investigate the effect of primary payer on the

hospital readmission rate after TJA, would Medicare patients be at lower risk of hospital readmission considering the policy changes in last 4 years.

1.5 Study purpose and Specific Aims.

Unlike other available datasets, discharge destinations are defined comprehensively and clearly in our dataset including discharges to home without any further medical care. This dissertation explores the effect of all possible discharge dispositions (i.e. direct to home, home with health services, and to post-hospital care settings) on the all-cause 30-day readmission rate after TJA procedures performed in the United State between January 1 and November 30, 2014. The theoretical motivation for this study follows the Donabedian model that provides a framework for examining health services utilization and evaluating quality of health care, incorporating some elements of the organizational design model (Donabedian, 1966; Nadler, 1988). For our purposes, a key strength of the organizational design model is to acknowledge that, in order to be successful in reducing the readmission rate (better outcomes), the decision regarding discharge destination after TJA must be tailored to the patient's needs and preference. The study takes a multidisciplinary approach to examine the effect of discharge dispositions on hospital readmission within 30 days of total joint replacement. Based on the results of this study, policy makers will better understand factors that may affect hospital readmission, so they can develop more fair and effective policies, or modify current policies to get patients the right care at the right time. Hospitals and caregivers will also be aware of where to send patients upon discharge, and finally patients will have

a better understanding of what is a suitable destination after hospital care, so they can participate on their own care. A secondary goal of this work is to describe how patient characteristics, and hospital related factors affect 30-day all-cause readmission rate after TJA in the U.S in 2014. Three specific questions are asked, two of which are essentially descriptive queries and one are is an analytic question:

1. Have there been differences in readmission rate between patients discharged direct to home without any form of post-acute care and those who received any type of post-acute care?

2. Have there been differences in readmission rate between patients who received post-acute care services at home and those discharged to post-acute care facilities?

3. what factors are associated with all-cause 30-day readmission rate after TJA in the United States in 2014? are there any differences in the TJA all-cause 30-day readmissions rate between payers?

1.6. Relevance

The implementation of the prospective payment system under Medicare in 1983 resulted in increased use of outpatient rehabilitation, as patients were being discharged earlier through the use post-acute care services as a mean to reduce acute care cost (Kane, Chen, Blewett, & Sangl, 1996). Previous studies that investigate the effect of discharge disposition on patient outcomes after TJA have demonstrated no significant difference in the overall functional outcomes of patients discharged to post-

acute settings when compared to patients discharged to home, or to home with health services, after TJA (Chimenti & Ingersoll, 2007; Kelly & Ackerman, 1999; Tribe et al., 2005). However, functional outcome studies on those works did not address the issue of postoperative complications that may have led to hospital readmissions. Buntin et al noted that patients who are discharged to a subacute setting after lower extremity joint arthroplasty have an 18% higher chance of either dying or going back to hospital within 120 days of discharge (Melinda Beeuwkes Buntin et al., 2005).

Some work has been done to address this concern, which demonstrated that, patients discharged home with health services had a significantly lower 30 day readmission rate compared to those discharged to inpatient rehab facilities (Ramos et al., 2014). However, these findings cannot be generalizable to other institutions as they used their hospital database, while ours is a nationally representative data; also, they did not address patients who discharge to home without any form of post-acute care services. On a related note, Keswani et al, used the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database and reached the same finding, but they also couldn't distinguish between patients who were sent home with health care services and those who were discharged to home with no further care (self-managed discharge destination) as their data does not support such limitation (Keswani et al., 2016). This is especially important in the case of the new bundled payments models that held hospitals accountable for patient outcomes and cost of care up to 90 days of discharge, increased emphasis is placed on fast discharge of patients to the most appropriate destination, so they can minimize the use of unnecessary post-acute care

services. Recently published work by Dundon et al, has demonstrated that, a 20% decrease on the cost per episode of care was achieved by reducing discharge to inpatient rehabilitation from 44% to 28%, they also reported reduction on the 30-day readmission rate by 2% (Dundon et al., 2016). A variety of nonclinical factors are likely affecting where patients go after hospital discharge. Researchers found a positive correlation between home health care use and the number of home health care agencies in an area (Kenney & Dubay, 1992). And another researcher has also found that, higher-income communities have higher utilization rates of post-acute care services (Neu et al., 1989). In the light of these findings, and the enactment of the bundled payments models, where the hospital is held responsible for clinical outcomes and costs up to 90 days after discharge, ensuring appropriate destination and high value post-acute care is more important than ever before.

A large, nationally representative sample of TJA patients that controls for a broad set of patient characteristics, hospital factors, and all possible discharge destinations including home with no rehabilitation, is needed to address the effect of discharge destinations on the readmission rate after TJA. This dissertation is using a large nationally representative dataset to compare 30-day readmission rate by discharge destination. A secondary focus is to identify patient, and hospital risk factors that contribute to all-cause readmissions within 30 days of discharge after TJA.

CHAPTER 2
LITERATURE REVIEW

2.1 Overview of Literature Review.

The national health expenditure in the United States is expected to increase to USD 5.4 trillion by 2024, rising from 17.4 percent in 2013 to 19.6 percent of the gross domestic product in 2024 (Keehan et al., 2015). The latest national health expenditures report by CMS has estimated that hospital care accounts for 32 percent of the entire healthcare spending in 2016 (cms.gov, 2018). The Agency for Healthcare Research and Quality (AHRQ) estimates that hospital stays caused by musculoskeletal procedures are more expensive and longer than other hospitalizations and represent a significant portion of the total cost of hospital care. Hospitalizations involving musculoskeletal procedures particularly hip replacement, and knee arthroplasty, cost about USD 20.1 billion in 2014, accounting for 12.3 percent of aggregate costs for all inpatient stays (Elixhauser, William, & Anne, 2017). However, hospital readmissions after hip, and knee arthroplasty account for nearly 5% of the amount spent on TJA hospitalizations; Kurtz and colleagues estimated the economic burden of hospital readmissions up to 90 days after TJA at approximately USD 1.1 billion (S. M. Kurtz et al., 2017a).

The challenge with healthcare reform is to improve the quality of care without increase spending. One opportunity for reining in medical costs and improving quality is to reduce unnecessary expensive hospitalizations.

Recent improvements in hospital care have come from growing knowledge of factors that contribute to readmission. Throughout the literature, most of the studies on the rates and risk factors of TJA readmissions are on Medicare patients, or are comprised of small single institution samples. Medicare studies are restricted to patients aged 65 years and older, while one-third of patients undergoing TJA are younger than 65 years and constitute the fastest growing group in the arthroplasty demand. (S. M. Kurtz et al., 2009) Single-center studies are undersized in their sample, lack the capability to capture readmission outside their specific hospital system, and produce results that are not generalizable to other hospital settings. Also , previous studies focused on patients' characteristics that contribute to rehospitalization within 30 or 90 days of the discharge, at a hospital level (V. Avram, D. Petruccelli, M. Winemaker, & J. de Beer, 2014; Cram et al., 2011; Cram et al., 2012; C. J. Lavernia & Villa, 2015; Pugely, Callaghan, Martin, Cram, & Gao, 2013). Other factors which relate to healthcare settings can, however, affect the readmission rate after total joint replacement; hospital ownership and teaching status have been found to negatively impact readmission rates after TJA (S. M. Kurtz et al., 2016a).

Therefore, investigating readmission risk factors for a large population of patients undergoing TJA is needed to detect differences in the effect of each factor. Also, studies

are needed that focus on care settings characteristics and the discharge destinations after TJA at the national level. Could there be an unwarranted assumption that discharge destinations contribute to any differences in the readmission rate in TJA? This research helps to fill the knowledge void by identifying and describing the readmission rate after TJA, and by evaluating factors for association with all-cause 30-day readmission rate after TJA in United States in 2014, using a nationally representative database that accounts for 51% of total US hospitalizations.

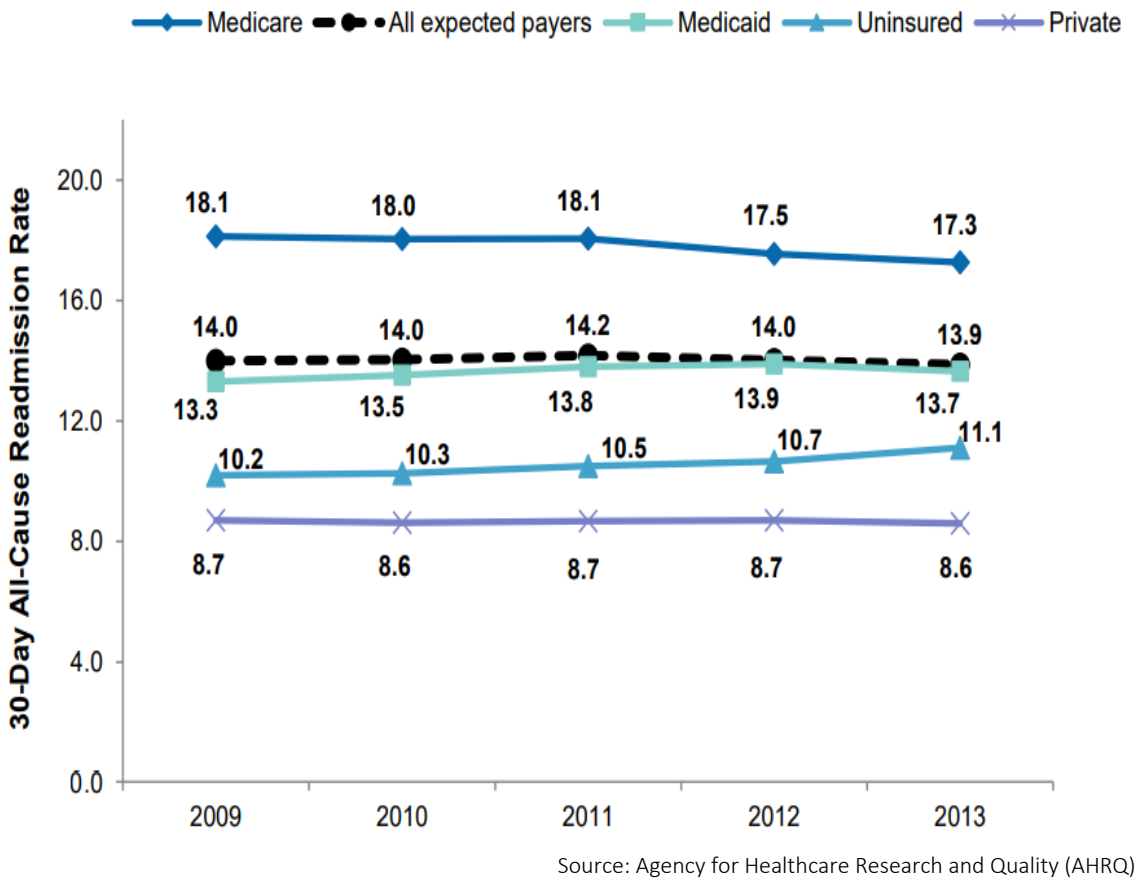
The Nationwide Readmissions Database (NRD) is part of the Healthcare Cost and Utilization Project (HCUP). Developed through a federal-state-industry partnership sponsored by the Agency for Healthcare Research and Quality. The NRD addresses a large gap in health care data: the lack of nationally representative information on hospital readmissions for all types of payers and the uninsured. The NRD is drawn from HCUP State Inpatient Databases program (SID) which contains reliable verified patient linkage numbers that can be used to track a patient across hospitals within a State, while adhering to strict privacy guidelines. The 2014 NRD is constructed from 22 SIDs. These states are geographically dispersed and account for 49.3 percent of the total U.S. resident population, and 51.2 percent of all U.S. hospitalizations. In fact, it is the only nationally representative database that is dedicated to the study of hospital readmissions, created to enable analyses of national readmission rates and to support public health professionals, administrators, policymakers, in their decision making.

2.2 Hospital Readmission.

As described by the Centers for Medicare & Medicaid Services (CMS), hospital readmission is subsequent inpatient admission to any acute care facility that occurs within certain periods after the discharge date of an eligible index admission. The time periods are defined as long as 90 days of discharge, and includes hospital readmission to any acute hospital, not just the hospital at which the patient was originally hospitalized. The Agency for Healthcare Research and Quality as well as the Medicare program use an "all-cause" definition of readmission, which means any hospital stays within 30 or 90 days of a discharge from initial hospitalization are considered readmissions, regardless of the reason for the readmission.

According to the CMS, historically about 19 % of total hospitalized Medicare patients were readmitted to the hospital within 30 days of their discharge. Prior to 2009, not much attention was paid to the hospital readmission rate. The Patient Protection and Affordable Care Act of 2010 included several initiatives in the form of payments and public recognition to provide incentive for hospitals to reduce hospital readmissions, aiming to improve health care quality. After being essentially unchanged from 2007 to 2011, the 30-day all-cause hospital readmission rate among Medicare fee-for-service patients declined to 18.4 % in 2012. It was more than half percentage point lower than the average rate between 2007-2012 (Gerhardt et al., 2013). However, Medicare beneficiaries still are the highest in 30-day all-cause readmission rate compared with those who had Medicaid, private insurance, or uninsured individuals (Agency for Healthcare, Quality, Markets, & Utilization, 2013). (Figure 2.1) presents trends in 30-day

all-cause readmission rate by expected payer from 2009 through 2013 created by the Healthcare Cost and Utilization Project (HCUP).



Source: Agency for Healthcare Research and Quality (AHRQ)

Figure 2.1 Rate of 30-day all-cause readmissions by expected payer, 2009–2013

Hospital readmission following TJA hospitalization has increased in the last 15 years. Cram and colleagues report an increase in 30-day all-cause readmission for Medicare population undergoing total hip arthroplasty from 5.9% to 8% between 1991 and 2008 (Cram et al., 2011). They also reported an increase in the 30-day all-cause

readmission rates from 4.2% in 1991 to 5.0% in 2010 after knee arthroplasty (Cram et al., 2012). In both of these studies Cram et al, report a change in patients' discharge disposition over time with a decline in the use of hospital care and an increase in the use of post-acute care services. However, the rapid increase in Medicare post-acute care spending in the 1990s prompted passage of the Balanced Budget Act (BBA) of 1997 and implementation of a prospective payment system (shifting payments from a cost basis to prospective payment) for outpatient skilled care in 1998 and inpatient rehabilitation in 2002 (Buntin, Colla, & Escarce, 2009; McCall, Korb, Petersons, & Moore, 2003). The consequent result of those polices, was a decrease in the use of post-acute care and an increase in the percentage of patients being discharged home after TJA since 2004. Policy changes played a significant role in patients' discharge disposition after TJA regardless of the effect on readmission rate. Knowing the effect of each discharge disposition on the readmission rate after TJA is essential to improving patient outcomes and lowing cost of care.

In addition to the variation of readmission rate among payers, hospital readmission also varies by location within the U.S. Kurtz et al. (2016) reported a significant degree of variation in the risk adjusted 30-day all-cause readmission rates after TJA in different areas of the U.S. As shown in (Figure 2.2) patients in the western states had the lowest 30-days readmission rates at 4.9%. Other census regions had 30-day readmission rate of 6.0%-6.3%, rates 10% - 16% higher than in the Western region. Rates were generally high in the Mid-Atlantic region, and certain areas in the South, and eastern Midwest.

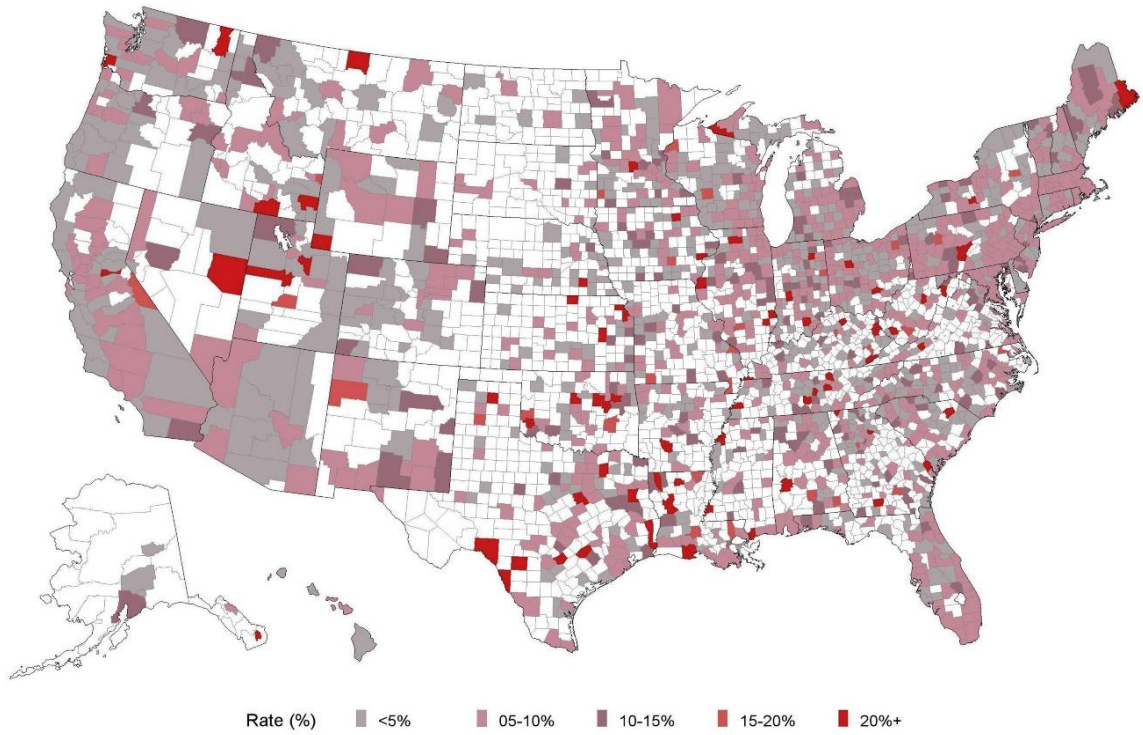


Figure 2.2 Risk adjusted 30-day Readmission Rates by state and county

Regional variation in avoidable readmission rates is an indication of inadequate quality of care, lack of appropriate coordination of post-discharge care, and inefficiency. In many cases the availability of post-acute care facilities is a major determinant of whether patients use such care after discharge from the hospital (M. B. Buntin et al., 2005). Inadequate care transitions planning, bad communication, and delays in scheduling post care services are among the most common causes of preventable readmissions (Bisognano & Boutwell, 2009). When patients are discharge from hospital, they experience differences in healthcare services they receive from diverse post-acute

care facilities such as Inpatient rehabilitations including skilled nursing setting, home healthcare, or home self-care.

2.3 Economic Burden of Hospital Readmission.

Readmission has been a major challenge in the health-care system as it is costly and common among most patients discharged from acute care hospitals (Jencks, Williams, & Coleman, 2009). Hospital readmission has accounted for estimated annual 17 billion dollars of unexpected cost for the federal government. Kurtz and colleagues estimated the economic burden of hospital readmissions after TJA at approximately USD 1.1 billion on the U.S healthcare system in 2013 (S. M. Kurtz et al., 2017a).

Bosco et al. (2014) studied readmission burden of TJA as a function of readmission rate, and they reported that , each 1.0 % increase in readmission rates following total hip arthroplasty results in an increase by 1.8% to the cost burden of these readmissions, and by 1.2 % to the cost burden after knee arthroplasty (Bosco, Karkenny, Hutzler, Slover, & Iorio, 2014). The Medicare Payment Advisory Commission (MedPAC) has estimated that 12% of readmissions are potentially avoidable. Preventing even 10% of these readmissions could save Medicare 1 billion dollars.

Increasing prevalence of TJA in recent years, has given more attention to hospital readmission following TJA, as it presents a large opportunity for cost saving and has therefore become a very popular target for bundled and fixed-cost programs by payers (Sood, Huckfeldt, Escarce, Grabowski, & Newhouse, 2011).

2.4 Studying Hospital Readmission. Why Is It Important?

Because of great developments in science, medicine, and technology, people's life expectancy has risen from 47 to 73 years during the last 100 year (Gulland, 2014). By 2050 the number of US adults aged 65 and older is estimated to increase to about 90 million (twice the current number). As this number increases, the prevalence of chronic diseases associated with advancing age will increase too. Considering demographic and epidemiologic changes in American society, providing health care services for a high number of elderly individuals with co-morbidities will present great challenges. An increase in the elderly population generally leads to an increase in the demand for health care services particularly hospital beds. It has been predicted that by 2030 demands for primary hip arthroplasty will exceed 500,000 cases a year, and the demand for primary knee arthroplasty will reach nearly 3.5 million cases, 673 % higher than the number in 2007 (S. Kurtz et al., 2007).

Due to the rising demands resulting in pressure on hospital beds, the early discharge of patients from acute hospitals has been observed to lower the length of hospital stay from 9 days in 2000 to 4 days in 2013. The consequences of early discharges include high hospital readmission rates and lower inpatient quality of care. Cram et al. found that over the last 20 years, the hospital length of stay for TJA Medicare patients has steadily decreased over time with an increase in readmissions and increased discharges to post-acute care settings where patients can continue to receive the appropriate medical and rehabilitative therapy they require after discharge (Cram et al., 2012). Thus, examining readmission rates after TJA by discharge disposition is critical in

regard to identifying the optimum setting where TJA patients should receive their care after hospital discharge. Also, one opportunity to reduce preventable readmission is to understand the factors that contribute to readmission. In a separate section of this study, some of the well-known factors that influence hospital readmission after TJA procedures will be discussed in more detail.

2.5 Policy and Interventions to Decrease Hospital Readmission.

At the end of the two-year national round table on Health Care Quality, all participants agreed on the lack of quality in the US healthcare system, both in the delivery of care and its financing mechanisms(Chassin & Galvin, 1998). Hospital readmissions are thought to be related to quality of care provided to the patient during the initial hospitalization. The wide variation in the hospital readmission rate across the country has supported this assumption, and consequently a proportion of hospital readmissions is avoidable (van Walraven, Bennett, Jennings, Austin, & Forster, 2011). Private payers and policy makers have highlighted the reduction of unnecessary hospitalization as a potential area for quality improvement and cost saving. They focused on a variety of initiatives in the form of payments and public recognition to reward hospitals that reduce the avoidable readmissions.

Hospital Readmissions Reduction Program(HRRP) requires the Centers for Medicare & Medicaid Services to reduce payments to hospitals if they have higher than expected risk-standardized 30-day readmission rates for TJA beginning in 2015 ("Readmissions-Reduction-Program," 2016). This is not the only initiative, but perhaps

the most important initiative in the effort to reduce hospital readmissions because it is difficult for hospitals to avoid.

Aligning health-care services' payment with patients' outcomes is a brilliant way to reform provider reimbursement. It is clear that, risk sharing strategies based on quality will likely be more common as the Federal government and other payers attempt to control costs without sacrificing quality. Payment mechanisms that promote a value-based model (an outcome-based contract) instead of the previous purely quantity-based model of Fee for Services (FFS) such as bundled payments are being introduced (Sood et al., 2011). Where health care providers are held accountable for what happens to patient up to 90 days of the initial stay, increased emphasis is placed on discharge of patients to the most appropriate care setting after hospital stay if needed.

Schneider & Mathios (2006) examined the differences in health care utilization across financial reimbursement arrangements using the principal Agency Theory, and they found that, contract designed payment is more efficient in controlling utilization when coupled with monitoring care services provided by the physician. From that point of view, the Agency Theory that explains that the relationship between principal and agent is driving this action (Schneider & Mathios, 2006), where the CMS is the principal and hospital are the agent. However, the new payment mechanism is not a fully outcome-based contract yet; it is a modified FFS, so the principal still needs to invest more in information to verify the agent's behavior. There is also the public reporting action component. In 2009, the CMS began publicly reporting hospital-level readmission

rates including TJA in 2015. And by doing that, policy makers are using a motivation tactic that has a combination of rewards and punishments to induce better performance.

Public reporting of quality measures aims to increase transparency and accountability within the healthcare system. As a result, patients can make decisions about where to seek healthcare services (looking for the better contractor/seller). Hospitals and Post-acute care facilities will improve the quality of their services to get a better reputation in the market. The combination of public reporting and researchers' growing interest in studying readmissions will increase transparency. Therefore, health care providers at all levels should consider a collaborative approach when delivering health services to eliminate unnecessary re-hospitalization and avoid the risk of losing revenue.

The Affordable Care Act called for public reporting of performance measures on quality, cost, and other metrics. The public reporting of 30-day risk-standardized readmission measures is consistent with the Institute for Healthcare Improvement (IHI) triple aim (Figure2.3).

Figure 2.3 IHI Triple Aim

1. Improve health care quality.

2. Improve the health of the US population.

3. Reduce the costs of health care.

Two federal agencies within the Department of Health and Human Services (HHS) are sharing the primary responsibility for the public reporting policy: The Agency for Healthcare Research and Quality (AHRQ), and the Centers for Medicare and Medicaid Services. AHRQ supports research, works with public and private stakeholders to develop quality measures, and reports aggregate national and state level data, while CMS collects data on performance measures and has developed a system to publicly report providers' performance measures ("QualityNet - Readmission Measures," 2017). Unlike other initiatives, both public reporting and the Hospital Readmissions Reduction program are mandatory, and there is no chance for participant hospitals to opt out.

The Partnership for Patients initiative was announced by the US Department of Health and Human Services on April 12, 2011. This five-year initiative aimed to improve the quality, safety, and affordability of healthcare. One of the PfP goals is to decrease hospital readmission by 20% by the end of 2013. ("Partnership for Patients | Center for Medicare & Medicaid Innovation," 2017). Three programs have been introduced to carry out initiative goals.

Hospital Improvement Innovation Networks, work at the regional, state, national and hospital system level to ensure continued harm reduction in the Medicare program, help to identify already proven solutions, and promote collaboration and teamwork among all participant hospitals and providers. By the end of September 2016 more than

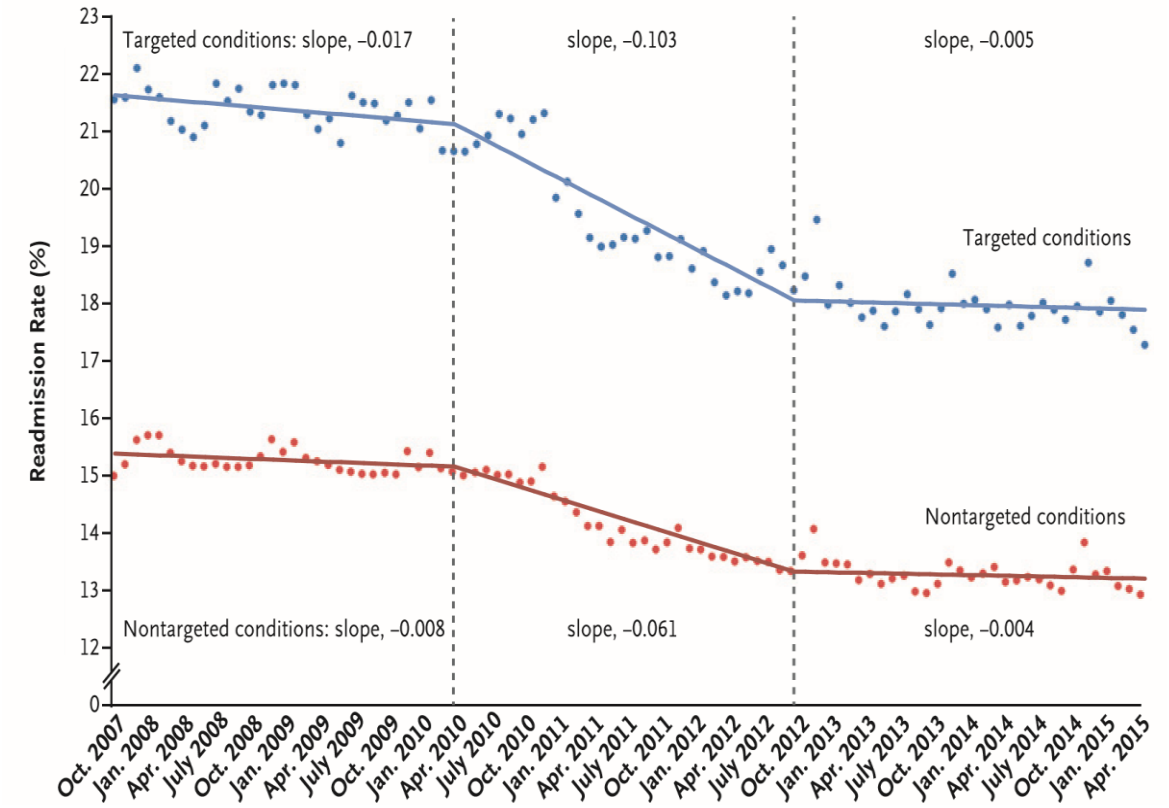
4,000 hospitals across 16 Hospital Improvement Innovation Networks (HIINs) were participating in Partnership for Patients ("About the Partnership - Hospital Improvement Innovation Networks," 2017).

The Centers for Medicare & Medicaid Services (CMS) has taken the next step in its mission to improve safety and reduce hospital readmissions for Medicare patients by awarding $347 million to those 16 health care organizations to serve as Hospital Improvement and Innovation Networks (HIIN). In October of 2016, CMS announced significant progress: an estimated 2.1 million fewer patients harmed, 87,000 lives saved and nearly $20 billion in cost savings from 2010 to 2014. CMS noted that efforts to address health equity for Medicare beneficiaries will be central to the HIINs' goals (CMS, 2016).

Transitions from one setting to another, especially being discharged from a hospital to an acute care facility, are often dangerous points in health-care. Inadequate care transitions planning, bad communication , and delays in scheduling post-acute services are among the most common causes of preventable readmissions (Bisognano & Boutwell, 2009). The Community-based Care Transitions Program (CCTP) is another program by the partner for patient initiative mandated by Section 3026 of the Affordable Care Act; the CCTP provided a framework for community-based organizations (CBOs) to partner with hospitals to address the needs of high-risk Medicare fee-for-service (FFS) beneficiaries after hospital discharge. Safe, effective, and efficient care transitions require thoughtful collaboration among health care providers including hospitals, and

post-acute care facilities. So, discharge destination after hospital stay has to be carefully chosen for vulnerable patients. Under the CCTP program, the CMS announced funding opportunities with up to $300 million in total funding being available for 2011 through 2015 for the acute-care hospitals that have high readmission rates to partner with community based organizations to provide care transition services aimed at improving a patient's transition from a hospital to another setting, and assist with post discharge needs, ("Community-based Care Transitions Program | Center for Medicare & Medicaid Innovation," 2017).

In a comparison study that investigated the effect of HRRP on hospital readmission rate , hospitals subject to penalties under the HRRP had greater reductions in readmission rate compared with non-penalized hospitals (Desai, Ross, Kwon, & et al., 2016). Another study by Zuckerman et al (2016) investigated the effect of the HRRP on the readmission rate and found that risk-adjusted rates of readmission for conditions that were included in the HRRP policy have declined more rapidly than other conditions, where readmission for targeted conditions declined from 21.5% to 17.8%, and rates for non-targeted conditions declined from 15.3% to 13.1%. Trends in readmissions are shown in (Figure 2.4). TJA wasn't included in the targeted conditions because it was added to the program during the study period in 2015.



Targeted conditions were acute myocardial infarction, heart failure, and pneumonia. Points represent the mean rate weighted by the number of hospital index stays during the month. Solid lines represent the predicted rates. Slopes are the monthly change in the predicted rates, generated from a linear combination of regression coefficients. Models are adjusted for seasonality with the use of an indicator for each 3-month season for targeted and nontargeted conditions; seasonal indicators are set equal to their means to generate a smooth predicted line. October 2007 through March 2010 was the period before enactment of the Affordable Care Act (ACA); April 2010 through September 2012 was the period of implementation of the Hospital Readmissions Reduction Program, which set financial penalties for hospitals that had higher-than-expected readmission rates for targeted conditions; and October 2012 through May 2015 was the long-term follow-up period after penalties were initiated. Dashed lines indicate divisions between periods. **Source**: (Zuckerman, Sheingold, Orav, Ruhter, & Epstein, 2016)

Figure 2.4 Change in 30-day Readmission Rates for Targeted and Nontargeted Conditions.

The Military Health System (MHS) was one of the first organizations to participate in the Partnership for Patients initiative, by implementing the first enterprise-wide patient safety initiative in June 2011 and, by the end of 2013, a reduction of 11.1% in

readmissions rate was achieved, as compared to the baseline rate in 2010, avoiding nearly 500 harm events since PfP implementation; and achieving approximately $13.5 million in cost avoidance (King et al., 2017). Where hospitals send patients makes a big difference in patient outcomes. The doctors have little official guidance or objective measurements to help them decide which patients will do best in each setting after hospital discharge, so measuring the effect of discharge destinations on the readmission rate is essential to develop such a tool, and the need for such a tool is more important than before as Medicare increasingly penalizes or financially rewards hospitals for reducing readmissions.

2.5.1 Payment Reform Landscape.

In 2010, section 3021 of the ACA established the Center for Medicare and Medicaid Services Innovation Center (CMMSIC), whose objective was to develop and investigate alternative payment models for reimbursements to address both quality and efficiency of health care services.

Another initiative that promotes coordinated and efficient care for TJA is the Bundled Payments for Care Improvement (BPCI) by the CMS Innovation Center, which has the potential to reduce expenditures while preserving or enhancing the quality of care for Medicare and Medicaid beneficiaries. Traditional Medicare payments pay providers separately for each of the individual services they provide to beneficiaries, which results in fragmented care with a low possibility of coordination across providers and health care settings (Stange, 2009). This new proposed approach is links payments for multiple services beneficiaries receive during an episode of care. This new payment

method is expected to lead to higher quality and more coordinated care at a lower cost to Medicare. The goal for this initiative is to improve patient care and quality through increased care coordination supported by payment innovation.

As shown in Table 2.1, The BPCI initiative is comprised of four broadly defined models of care with a prospective payment method that is designed to test whether linking payments for all providers involved in delivering an episode of care can reduce Medicare costs, while maintaining or improving quality of care.

Table 2.1 Bundled Payments for Care Improvement Initiative Design .

Model #	Model 1	Model 2	Model 3	Model 4
Episode	All DRGs; all acute patients	Selected DRGs; hospital plus post-acute period	Selected DRGs; post-acute period only	Selected DRGs; hospital plus readmissions
Services included in the bundle	All Part A services paid as part of the MS-DRG payment	All non-hospice Part A and B services during the initial inpatient stay, post-acute period and readmissions	All non-hospice Part A and B services during the post-acute period and readmissions	All non-hospice Part A and B services (including the hospital and physician) during initial inpatient stay and readmissions
Payment Type	Retrospective	Retrospective	Retrospective	Prospective

Source: Centers for Medicare & Medicaid Services

Model 2 of the BPCI bundles is a retrospective payment that includes acute care hospital services expenses plus the post-acute care expenses, as well as all professional

services up to 90 days after hospital discharge. TJA, one of the targeted procedures, is the most common among all 48 clinical episodes included in this policy.("Medicare Program; Comprehensive Care for Joint Replacement Payment Model for Acute Care Hospitals Furnishing Lower Extremity Joint Replacement Services. Final rule," 2015). CMS launched the BPCI initiative under the authority of the Medicare and Medicaid Innovation Center. The goal of this initiative is to foster efficient collaborative care while reducing costs and protecting or improving the overall quality of care for patients who undergo TJA.

Hospitals, physician groups, post-acute care providers and other entities, entered in to agreements with CMS to be held accountable for total Medicare episode payments which are, expected to lead to higher quality and more coordinated care at a lower cost. However, episode-of-care payment for joint arthroplasty varies widely depending on patient's health status, the procedure performed, and the readmission rate. Also, post-discharge service expenses account for more than a third of total episode expenditures (K. J. Bozic, Ward, Vail, & Maze, 2014). Thus, reducing the readmission rate, and adjusting patient expectations for going home rather than to an inpatient facility are key factors to avoiding a financial burden, which align with the policy's overall goal of reducing health care costs and increasing the value of the health care system. (Figure 2.5) below is a basic map of where intervention is happening.

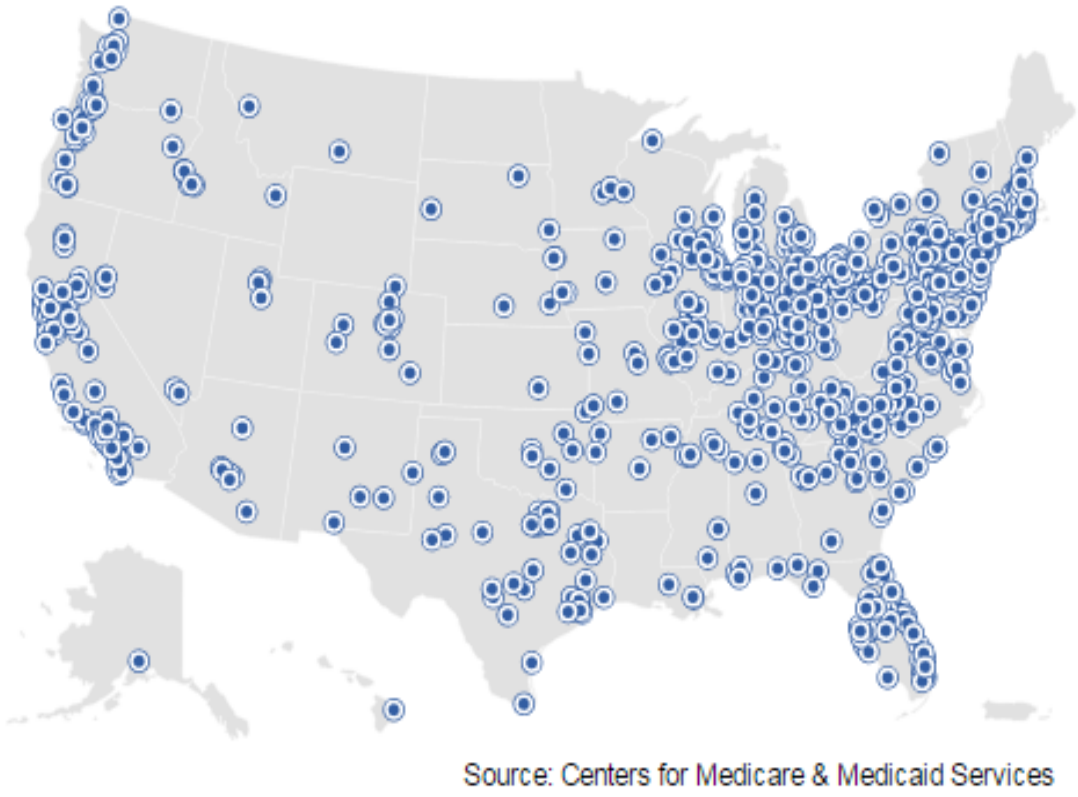


Figure 2.5 Health care facilities where Innovation Models are being tested.

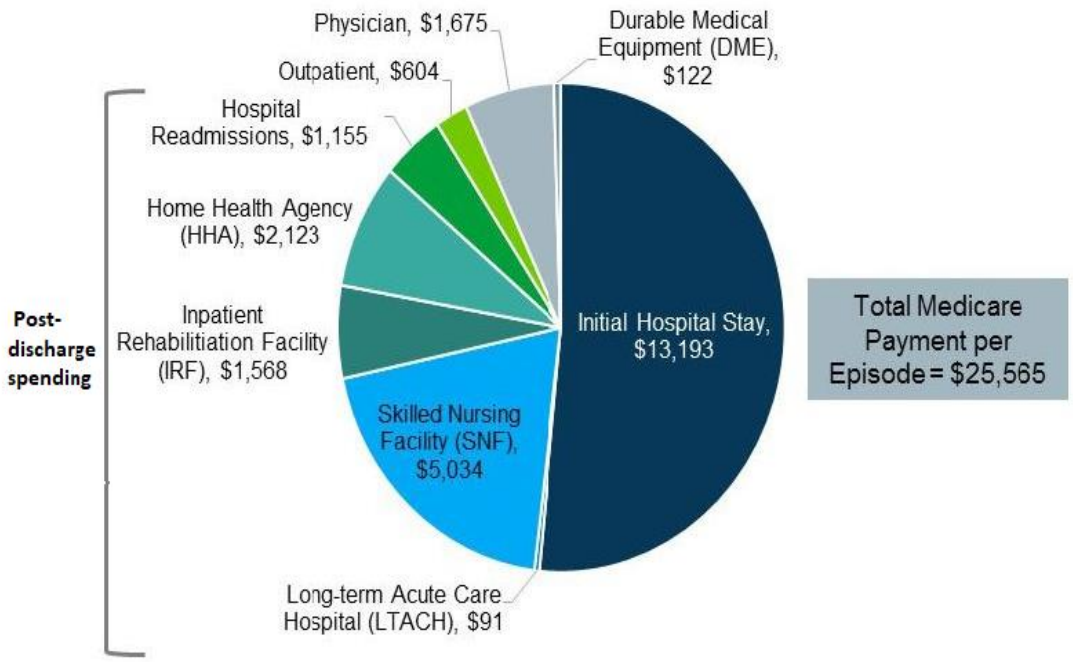
Effective on January 15, 2016, the Comprehensive Care for Joint Replacement (CJR) model is an alternative payment model created for Medicare beneficiaries by CMS to support better and more efficient care for those patients undergoing inpatient hip and knee replacement surgeries.

For five years, this model will test bundled payment and quality measurement for episodes of care associated with hip and knee replacements to encourage hospitals, physicians, and post-acute care providers to work together to improve the quality and

coordination of care from the initial hospitalization through recovery. CMS has implemented the CJR model in 67 geographic areas, including counties associated with a core urban area that has a population of at least 50,000; no urban core area with a population of less than 50,000 was eligible to participate. As of February 1, 2018, approximately 465 Inpatient Prospective Payment System (IPPS) hospitals in 67 different metropolitan statistical area (MSAs) are participating in this CJR model.

The CJR program represents the efforts that CMS put into reforming payments under the value-based care model by 2018. Participants are encouraged to work closely with physicians and post-acute care facilities to reduce fragmentation of care, improve quality of care, and reduce costs. For the five years of the program, CMS estimates a saving of $343 million, which is expected to be from reduced readmissions and increased use of post-acute care, such as skilled nursing facilities(SNFs) ("Medicare Program; Comprehensive Care for Joint Replacement Payment Model for Acute Care Hospitals Furnishing Lower Extremity Joint Replacement Services. Final rule," 2015).

Figure 2.6 below is a pie chart created by a data analytics consulting company (Avalere) that illustrates payment allocation for an episode of care for a joint replacement procedure. They used a 100% of Medicare claims data to find out the average Medicare payment for a total joint replacement procedure (Seidman, 2016).



Source: Avalere analysis of the 2012, 2013 and 2014 Medicare Standard Analytical Files. Includes episodes initiating between Jan 1, 2012 and Sept 30, 2014. Physician and DME payments estimated using 5% national sample, all other payments reflect averages derived from 100% of Medicare claims nationally. Avalere analysis excludes all physician and outpatient spending from the post-discharge period.

Figure 2.6 Average Medicare Payment per CJR Episode, by Care Setting.

Healthcare providers are concerned about the financial penalties and being held accountable by payers and policy makers for what happens to patients after being discharge from their facilities, wondering to what extent the gaps in performance for which they are being held responsible are actually under their supervision. Earlier work included 3282 hospitals across the country found that, large hospitals and teaching hospitals are more likely to be penalized than smaller, nonteaching hospitals (Joynt & Jha, 2013), it is unclear why these hospitals have higher readmission penalty than others. However, previous studies suggest that readmissions after TJA are often attributable to

patient medical comorbidities or socioeconomic status (Keeney et al., 2015). So, variation in readmission rates among hospitals may be driven by patient's sociodemographic factors and does not have anything to do with hospital performance.

Despite these criticisms of the new payment models, policy makers and healthcare providers share the belief that it is possible to better anticipate hospital readmissions and possible to avoid them. Healthcare providers have agreed that they play an important role in patients successfully transitioning from hospital to post-acute setting or to home. In January 2013, a large, tertiary, urban academic medical center started the Bundled Payments for Care Improvement (BPCI) initiative for TJA. They implemented the BPCI Model 2 for TJA in January 2013 and started the financial risk phase in October 2013. The Model 2 episode of care is a discounted retrospective form of payment from CMS that includes a 3-day hospital stay prior to the procedure, the inpatient, and post-acute care including procedural, physician, and all consultant fees and all costs through 90 days after the discharge. The final results show a 2% decrease in 30-day readmissions compared to the baseline year, and a reduction of 0.62 day in length of stay compared to the baseline year for the targeted patient population. Another finding worth mentioning here is that post-acute discharge costs were lowered by decreasing the use of inpatient post-discharge care services; patients were encouraged to go home rather than to an inpatient facility (Dundon et al., 2016). The significant financial risk associated with reimbursement penalties have likely led to a variety of improvements in healthcare outcomes. However, further research is needed to investigate different interventions and their impacts on readmission rates after TJA, care outcomes, patients'

access to care, and use of less expensive care settings such as acute hospitals, home health care, inpatient rehabilitations. Many factors must be examined to be able to obtain a comprehensive view of the 30-day readmission rate, including: the effect of patient characteristics; the effect of hospital characteristics, and the effect of after-hospital discharge settings. This research may provide better insights into the current or future interventions to facilitate readmission risk adjustment methods that appropriately account for patient factors, and discharge destination after TJA.

2.6 Risk Factors for Readmission.

Factors that influence the readmission rate can be thought of in three independent segments that relate to patients, delivery of care, and health care setting. Patient demographic factors that affect readmission rate such as age, gender, income, and payment source, as well as patients' clinical factors such as severity of illness, Body Mass Index (BMI), and chronic illness, have been intensively studied over the last 15 years. Providers' performance and process of care have also been found to have a significant impact on the rate of hospital readmission (Bisognano & Boutwell, 2009). Additionally, care setting characteristics such as: ownership, teaching status, location, have also been studied to investigate the impact on the readmission rate among TJA patients(S. M. Kurtz et al., 2016b).

An Individual's characteristics are important factors in whether a patient will be readmitted to a hospital (AMA, 2011). Because of the increased association between aging and the prevalence of joint arthroplasty (Maradit Kremers et al., 2015), one key

question for health care providers is whether a patient's age is associated with a greater risk of readmission.

There have been differing conclusions regarding the effect of age on the joint arthroplasty outcomes in the literature. In a recent cohort study of nearly 2000 patients who underwent primary TJA at a large academic medical center by Fang et al. (2015), outcomes where compared in patients stratified by age that was categorized by decade (≤50, 51-60, 61-70, 71-80, and ≥81). They found that, there was no statistically significant difference in all-cause 30-day readmissions between age groups. The result was supported by another cohort study of 502 patients older than 65 years who underwent TKAs or THAs in a large regional health system from January 2008 to September 2008 by Higuera et al. (2013): they did not find an association between age and the readmission rate during that period. However, in that same study, the authors concluded that, in terms of complications, patients were approximately 40% more likely to have at least one complication for every 10 years of age.

Despite these findings, there are substantial data that suggest that a patient's age is a predictor of hospital readmission. Jauregui et al. (2015) compared outcomes including readmission rate of TJA between patients <90 years of age vs. >90 years. They found that the nonagenarians group had higher readmission rate than the control group (6.9% vs. 3.8%; P = 0.005). This is consistent with the finding of Miric et al. (2014), who reported a statistically significant difference in the readmission rate among their study groups, with the rate among nonagenarians nearly tripling the rate seen in patients under 80 years old. Regardless of the effect of age on the outcomes after TJA, all studies

above have reported an increase in the use of post-care services among older patients compared with middle and younger age groups, which might be related to the overall health status of older patients, including their physical capability after such major surgery.

Readmission rates vary across patients' sex, with females having a slightly higher readmission rate (59%) than male patients (41%) (Victoria Avram, Danielle Petruccelli, Mitch Winemaker, & Justin de Beer, 2014). S. M. Kurtz et al. (2016a), who studied readmission after total hip arthroplasty using 100% Medicare data set (2010-2013) also found the same results, where female patients had a higher readmission rate than men with a difference of 20% between the two gender groups.

In addition to age and gender, personal economic status has also been recognized as a factor that influences hospital readmission after joint arthroplasty. Oronce et al. (2015) utilized the California State Inpatient Database (SID) to study the association between the incidence of unplanned readmission and patient socioeconomic status. They found that, patients living in high-poverty neighborhoods were 24% more likely than others to be readmitted (OR= 1.24; 95% CI, 1.10–1.39). Furthermore, in that same study authors discovered that, Medicaid patients had a readmissions rate that was 6.8% higher than privately insured patients. Mesko et al. (2014), who studied demographic factors associated with readmission after primary TJA, also found that the insurance payer is the only factor that shows an independent association with readmission, where government insured (Medicare/Medicaid) patients comprise the highest proportion of patients readmitted to a hospital within the first 30 days of discharge. In addition to demographic

factors, it is worth paying attention to how much patient clinical factors such as weight, severity of illness, and the existence of chronic condition impact the readmission rate after TJA.

The National Health and Nutrition Examination Survey of 2007-2008 reported a substantial increase in obesity within the United States population (Flegal, Carroll, Ogden, & Curtin, 2010). Obesity is widely acknowledged as a risk factor for both the incidence and progression of joint disease (Anandacoomarasamy, Fransen, & March, 2009). In a systematic literature search by Blagojevic et al. (2010), the pooled odds ratio for developing knee osteoarthritis was 2.63 times CI (2.28-3.05) greater for obese patients compared to normal-weight patients. Lementowski and Zelicof (2008) reported a 36% increased chance of developing degenerative joint disease for every 2-unit (5 kg) increase in body mass index. Considering that, the prevalence of obesity is not expected to change (Flegal, Carroll, Kit, & Ogden, 2012), defining the relationship between obesity and arthroplasty outcomes become increasingly important. In a recent published study by Chen et al. (2016), the relation between Body Mass Index and 30-day readmission is positively correlated, where the risk of getting readmitted increases as the BMI increases. Beside the risk of readmission, a study examined obesity's impacts on the other outcomes found a negative impact of obesity on patients' clinical function and patients' satisfaction after TJA (Järvenpää, Kettunen, Soininvaara, Miettinen, & Kröger, 2012). However, obesity-related complications should be considered when performing such a study.

Hospital-related variables associated with readmission risk after joint arthroplasty have been previously studied by Kurtz, Lau et al , who used Medicare 100% national hospital claims data and found that , Hospital procedure volume, rural hospital location, and hospital ownership were the only significant hospital factors that were associated with the risk of 30-day readmission after total knee arthroplasty (S. M. Kurtz et al., 2016b).

2.7 Use of Total Joint Arthroplasty Readmission as Quality Metric.

The primary treatment goal of TJA is the restoration of independence in the activities of daily life by reduction of pain and disability**,** so in such surgery, the most direct measures of quality are outcome measures, because assessing pain, functional status, and quality of life before and after surgery can be easily measured (Brady, Masri, Garbuz, & Duncan, 2000). In a study by Harvard School of Public Health, that studied 30 day hospital readmission after six major surgeries including total hip replacement procedure found that, surgical-readmission is associated with surgical quality , given the policymaker the confidence to use surgical readmission rates to rank and pay hospitals (Tsai , Joynt , Orav , Gawande , & Jha 2013).

The readmission rate within 30-days of discharge has been used as a hospital quality measure for a long time (Ashton & Wray, 1996; Vorhies, Wang, Herndon, Maloney, & Huddleston, 2011) , and it has become a well-known cost efficiency metric for policy makers (Adelani, Keeney, Nunley, Clohisy, & Barrack, 2013; Rutledge Carter Clement et al., 2013). An association between readmission rate and the quality of health

care services has been reported in numerous studies (Ramos et al., 2014). In a study that investigated the validity of the readmission rate as a routine indicator of the quality of hospital care, the authors concluded that “adjusted rates of potentially avoidable readmissions are scientifically sound enough to warrant their inclusion in hospital quality surveillance” (Halfon et al., 2006). In the interest of promoting high-quality, patient-centered care and accountability, CMS has identified hospital-level 30-day risk-standardized readmission rates following an elective primary total joint replacement as a quality outcome for US acute hospitals, assuming that great clinical variation among US hospitals represents an opportunity to improve both quality of care and the cost effectiveness of services provided ("QualityNet - Measures," 2018)

While outcome measures including readmission may seem to represent the “gold standard” in measuring hospital quality, the use of inadequately adjusted rates may lead to inappropriate conclusions regarding a hospital’s quality. Several problems with the use of readmission rate as a quality metric have been noted, including the effects of variables outside of a hospital’s control such as patient and community related factors. Thus, risk-adjustment methods that correct for differing characteristics within a population, such as patient severity of illness can help account for some of these factors (Carlos J. Lavernia, Laoruengthana, Contreras, & Rossi, 2009).

However, the use of alternative care settings after discharge from an acute hospital, such as short-stay hospital, outpatient observation status, and other types of outpatient care facilities, may influence the readmission rate, undermining the use of the readmission rate metric in quality initiatives. The subacute care settings might be

clinically adequate, and a more cost-efficient alternative compared to the expensive acute care settings. Therefore, the influence of post-acute care settings on the readmission rate should be evaluated to determine whether quality interventions are the main driver of change in the readmission rate.

2.8 Incorporating Severity of Illness and Comorbidity in TJA.

The characteristics of patients who qualify for TJA vary. Some patients are relatively young and healthy, whereas others are old and suffer from several comorbid diseases that are not related to the principal diagnosis. Researchers have found that, medical co-morbidities contribute to hospital readmissions and in some cases to reoperations which increases the cost and the consumption of healthcare resources.(Olthof, Stevens, Bulstra, & van den Akker-Scheek, 2014). Therefore , there is a need for a classification tool to assess patient comorbidities prior to the medical intervention because they may delay diagnosis, alter treatment ,or even affect the analysis when measuring patient outcomes (Feinstein, 1970).

The American Society of Anesthesiologist physical status classification system (ASA) is a risk stratification tool that is used to classify patients based on their pre-operative medical status. Schaeffer and colleagues examined the correlation between ASA score and readmission rates in TJA patients. They find that patients with an ASA score of ≥ 3 are at 2.9 times greater risk of readmission (P= 0.0082) (Schaeffer et al., 2015).

However, hospital administrative data have been widely used for examining issues related to payment, cost, utilization, and patient outcomes. All these topics require adjustment for patient severity of illness. Researchers can develop their own methods or select one of the severity measurement systems available in the public or private domain. The All Patients Refined Diagnosis Related Groups Severity of Illness levels (APR DRG-severity) is another widely used classification system to address patients' severity of illness ("Healthcare Cost and Utilization Project (HCUP) NRD Notes," 2018). Amit et al, found that, the APR-DRG severity-of-illness classification is a useful tool for planning tailored, cost-effective patient care preoperatively in joint arthroplasty (Shah, Vail, Taylor, & Pietrobon, 2004). Bozic et al , also found that, the APR-DRGs severity was predictive of hospital costs in patients receiving TJA (Kevin J. Bozic, Rubash, Sculco, & Berry, 2008). The Agency for Healthcare Research and Quality has selected the APR-DRG system to be used as a severity-adjustment tool, and to be included in the latest refinement of the Healthcare Cost and Utilization Project Quality Indicators.("Healthcare Cost and Utilization Project (HCUP) NRD Notes," 2018).

2.9 Use of Healthcare Cost and Utilization (HCUP) Dataset.

Patient privacy regulations and the lack of reliable patient identifiers that enable the tracking of patients in hospital administrative data were obstacles in pursuing readmission studies at the national level. But the Agency for Healthcare Research and Quality's (AHRQ) released a new large administrative inpatient dataset in November 2016 called Nationwide Readmissions Database (NRD) that enables researchers to conduct

various types of analyses of national readmission rates for all payers and the uninsured. The NRD is drawn from HCUP State Inpatient Databases (SID) containing verified patient linkage numbers that can be used to track a person across hospitals within a state, while adhering to strict privacy guidelines. Unweighted, the NRD contains data from approximately 15 million discharges in 2014. Weighted, it estimates roughly 35 million discharges in the United States. Using such data is a key factor to understanding the effects that discharge destination and hospitals' discharge volume have on the probability of hospital readmission at the national level. Since this dataset accounts for 51.2 percent of the total U.S. resident population and 49.3 percent of all U.S. hospitalizations, perhaps this study's greatest utility lies in the validation and comprehensiveness of this dataset.

2.10 Summary of Literature.

Articles relevant to this work have been identified using a MEDLINE database search. We performed a search using the terms: on rehospitalization, readmission, Total Joint Arthroplasty, joint replacement, knee replacement, hip replacement, and care transitions. We used a combination of these terms, performing a Medical Subject Heading (MeSH) search in PubMed. We limited our search period from January 2005 to January 2017 and only included English language studies, and human studies. Additional articles and policy briefs were used, such as the ones that were recommended by AHRQ, and frequently cited articles that have been identified via the literature search.

Previous studies that investigated the effect of discharge disposition on patient outcomes after TJA were limited but have demonstrated no significant difference in the overall functional outcomes of patients discharged to post-acute settings when compared to patients discharged to home, or to home with health services after TJA (Chimenti & Ingersoll, 2007; Kelly & Ackerman, 1999; Tribe et al., 2005). However, functional outcome studies did not address the issue of postoperative complications that may lead to hospital readmissions; hospital readmission rate also was not reported in these works. Buntin et al noted that patients who are discharged to a subacute setting after lower extremity joint arthroplasty have an 18% higher chance of being either dead or going back to hospital within 120 days of discharge(Melinda Beeuwkes Buntin et al., 2005). Some work has been done to address this concern, which demonstrated that patients discharged home with health services had a significantly lower 30 day readmission rate compared to those discharged to inpatient rehab facilities (Ramos et al., 2014). Furthermore, these findings cannot be generalized to other institutions as they used a single hospital database; also, they did not address patients discharge to home without any form of post-acute care services. On a related note, Keswani et al, used the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database and reached the same result, but they also couldn't distinguish between patients who sent home with health care services and those who discharge to home with no further care (self-managed discharge destination) (Keswani et al., 2016). This is especially important in the case of the new bundled payments models that hold hospitals accountable for patient outcomes and cost of care up to 90 days of discharge, as

increased emphasis is placed on fast discharge of patients to the most appropriate destination, so they can minimize the use of unnecessary post-acute care services. Recently published work by Dundon et al, has demonstrated a 20% decrease on the cost per episode of care that was achieved by reducing discharge to inpatient rehabilitation from 44% to 28%; they also reported reduction on the 30-day readmission rate by 2% (Dundon et al., 2016).

A variety of nonclinical factors are likely affecting where patients go after hospital discharge. Researchers found higher-income communities have higher utilization rates of post-acute care services (Neu et al., 1989), so patient's type or lack of insurance plays a role where patients go after hospital care. In the light of these findings, and the enactment of the new bundled payments models, where the hospital is held responsible for clinical outcomes and costs up to 90 days after discharge, ensuring appropriate destination and high value post-acute care is more important than ever before.

In order for hospitals and other caregivers to provide the best possible care services to their TJA patients, they need to know where to send their patients after discharge; also patients need to have reliable and understandable information in order to participate on that decision.

A large nationally representative sample of TJA patients that controls for a broad set of patient characteristics, hospital factors, and all possible discharge destinations including home with no further rehabilitation is needed to assess the effect of all possible discharge destinations on the readmission rate after TJA. To fill that void, this dissertation is using Nationwide Readmissions Dataset designed by H-CUP, a large nationally

representative dataset to compare 30-day readmission rate by discharge destinations after TJA. A secondary focus is to identify patient, and hospital risk factors that contribute to all-cause readmissions within 30 days of discharge after TJA.

CHAPTER 3
METHODS

3.1 Study Design

The study design is a secondary analysis of longitudinal data on TJA patients and their hospitalizations over a 30-day period following the index admission. Studying patients that repeatedly use or cross between health care settings such as hospital inpatient, and post-acute care, is difficult for many reasons, including a lack of patient identification number that enable tracking of patients in hospital administrative data, as well as privacy concerns. We are utilizing a recently developed nationwide readmission database from the Healthcare Cost and Utilization Project, which contains verified patient linkage numbers that can be used to track a patient across care settings within a state, while adhering to strict privacy guidelines.

The hospitals included in the database are community hospitals, defined as short-term, non-federal, general, public, academic, or other hospitals, excluding hospital units of other institution; our data include 2048 community hospitals in 22 states. HCUP data excludes rehabilitation and long-term acute care hospitals. Veterans Hospitals and other federal hospitals are also excluded (2014 Agency for Healthcare Research and Quality, 2018a). The dataset excludes patients with missing or questionable patient linkage numbers. Also, all discharges from hospitals that have more than 50 percent excluded of

their total discharges were entirely excluded, because patients treated at these hospitals may not be reliably tracked over time.

Our study's focus is the inpatient index hospitalization and all-cause 30-day readmissions, hospital and patient characteristics, primary diagnosis, severity of illness, and patient discharge disposition. TJA readmissions could occur for any reason at the same or a different hospital during the study time period. Transfer on the same day does not count as readmission, if a patient was transferred to a different hospital on the same day or was transferred within the same hospital the two events are only counted once, and the second event was not counted as a readmission. Every qualifying hospital stay is considered as a separate index admission, so one patient can have multiple index admissions regardless of how far apart they occur during the study period. Also, an index admission does not require a prior "clean period" with no hospital stay, that is, a hospital stay may be a readmission for prior stay and an index admission for a subsequent readmission. Admissions were disqualified as index admission if they could not be followed for 30 days.

Qualifying index event criteria was an adult discharged alive after Total Knee/Hip replacement procedure. Every qualifying hospital stay is counted as a separate index admission, which is the starting point for follow-up to check for readmissions. Thus, a single patient can be counted multiple times and can have multiple index stays during the observation period (January 1st to November 30th). The readmission is subsequent hospital admission in the same or a different hospital within 30-day of the original admission discharge date for any reason. Patients with qualified index admission are

followed from January to November which allowed a 30-day window from each index event to find out the readmission cases.

Readmission rate will be calculated as, number of TJA stays with at least one readmission stay for any reason within a month of previous discharge, divided by the number of stays with an admission for TJA in first 11 months of 2014. This approach may count a readmission in January as an index event, as the data from December of previous year is not available, Also the approach used to calculate readmission rate in this study is different than the one used by CMS to calculate readmissions rate following elective total hip and/or knee arthroplasty; the CMS formula for readmission rate is computed using a three-year rolling period of measurement of computed excess readmission over expected that is different than the one used in this work . See Appendix A for more details on the approach used in this study.

Patient's disposition, defined as the consequent arrangement or event ending a patient's encounter in the reporting facility. To make codding uniform across HCUP data sources, the variable (*DISPUNIFORM)* combines detailed categories in the more general groups including: (1) Routine discharge , which mean discharged to home or self-care; (2) Transfer to short-term hospital; (5) Transfer to Skilled Nursing Facility (SNF), Intermediate Care Facility (ICF), and another type of facility; (6) Transfers to Home Health Care, under care of organized home health service organization in anticipation of covered skilled care; (7) Against medical advice (AMA) ; (20) Died in hospital.

American Hospital Association (AHA) Annual Survey of Hospitals will be used to identify hospital characteristics such as ownership, number of beds, teaching status, and urban-rural location.

The study population will be risk-adjusted using the severity level variable (APR-DRGs) four categories of severity of illness which been developed to reflect the clinical complexity of the patient population. The APR-DRG SOI determines the extent of system breakdown or organ dysfunction. There are 4 levels of the SOI subclass ranging from 1 to 4. A higher number indicates multiple, serious diseases, and associated interaction.

Patient characteristics, hospital characteristics, payer characteristics, and discharge disposition have been categorized. The time frame of this study included any total joint arthroplasties, Knee or Hip between January 1st and November 30th, of 2014.

3.2 Data Sources.

3.2.1 Overview of the NRD.

The NRD is the only nationally representative database that is dedicated to the study of hospital readmissions, created to enable analyses of national readmission rates and to support public health professionals, administrators, policymakers, in their decision making. The Nationwide Readmissions Database (NRD) is part of the Healthcare Cost and Utilization Project (HCUP) database. Developed through a federal-state-industry partnership sponsored by the Agency for Healthcare Research and Quality, the NRD addresses a large gap in health care data, the lack of nationally representative information on hospital readmissions for all types of payers and the uninsured. The NRD is drawn from HCUP State Inpatient Databases program (SID) which contains reliable

verified patient linkage numbers that can be used to track a patient across hospitals within a State, while adhering to strict privacy guidelines. The 2014 NRD is constructed from 22 SID. These states are geographically dispersed and account for 49.3 percent of the total U.S. resident population, and 51.2 percent of all U.S. hospitalizations. Appendix B, (Table1) identifies the statewide data organizations that contribute to the NRD. For information on the geographic distribution of the 22 HCUP Partner organizations participating in the 2014 NRD see Appendix B (Figure1).

The NRD is limited to data from community hospitals that are not rehabilitation or LTAC facilities. Non-community hospitals were excluded because of inconsistent capture of data across HCUP States. Rehabilitation or LTAC hospitals were excluded because they treat a unique patient population that has longer stays and higher costs. Information on the percentage of SID discharges excluded by type of exclusion provided in the Appendix B, (Table2). Details on the number of hospitals in the NRD are provided in Appendix B, (Table3).

After exclusions, the 2014 NRD contains about 85 percent of total SID discharges from the participating states. Unweighted, the NRD contains approximately 15 million discharges in 2014. The HCUP calculated discharge weights for each NRD record based on the patient and hospital stratum in the SID data to represent roughly 36 million discharges in the United States.

3.2.2 Data Structure

The NRD includes three discharge-level files, and one hospital-level file.

• Discharge-level files

- Core File: Contains data elements critical to readmission analyses.
- Severity file: Contains additional data elements to aid in identifying the severity of the condition for a specific discharge (e.g., comorbidity flags, 3M All-Patient Refined Diagnosis-Related Group [APR-DRG] value, risk of mortality, and severity).
- Diagnosis and Procedure Groups File: Contains additional information on the diagnoses (e.g., chronic condition indicators) and procedures (e.g. procedure class).

• Hospital-level File: Contains information on hospital characteristics.

The four files were opened, sorted, and merged by unique record identifier (KEY_NRD) using STATA's command (merge) to create a master file to be used in this study.

3.3 Study Population

The study population is all adult patients who underwent a primary Total Joint Arthroplasty in 2014, who were discharged alive from community hospitals, excluding rehabilitation or long-term acute care hospitals, from 22 participating partner states from all regions of the United State and account for 49.3 of the total US resident population and 51.2 of all US hospitalizations.

Out of state residents were excluded because the HCUP patient linkage numbers only can follow a patient within a state. Total joint arthroplasty discharges were identified using ICD-9- Procedure codes (N=483,051) were extracted.

3.3.1 Exclusion Criteria

In addition to the NRD data exclusions in APPENDIX A Table2, Exclusion criteria for admission and readmission in this study are illustrated in table3 below.

Table 3.1 Study Exclusion Criteria.

Out of state residents were excluded because the HCUP patient linkage numbers only can follow a patient within a State.
Patients who died while inpatient during the index hospitalization (because there was no chance for readmission.
Patient with missing (NRD_Days ToEvent) the admission date or missing (LOS) length of stay also were excluded, because both are important to calculate time between admissions.
Patients who were discharge against medical advice; because patient will not have the opportunity to receive full medical care that he/she need prior to the discharge.
Patients who were discharged to unknown destination.

3.4 Measurement of Variables

3.4.1 Primary outcome Measure

For each hypothesis tested in this study, the primary outcome was the presence or absence of readmission event for any condition within 30 days of index TJA admission.

Patients undergoing primary THA and TKA were identified in the NRD using International Classification of

Diseases, 9th Revision, Clinical Modification (ICD-9-CM) procedure codes 81.51 and 81.54, respectively, while readmission can be any reason within 30-days of the index discharge date.

The Healthcare Cost and Utilization Project provide step by step online tutorial that explains how to use the Nationwide Readmissions Database, or NRD, to produce national estimates of inpatient readmissions for any condition (Tutorial, 2018).

Three HCUP data elements are critical to tracking a patient and determining the time between admissions: NRD_VisitLink, NRD_DaysToEvent, and LOS (length of stay).

Patient Linkage Number (NRD_VisitLink).

NRD_VisitLink is the data element that links for all inpatient stays associated with a unique patient. All discharges in the NRD include a value for NRD_VisitLink. The value was assigned based on a unique combination of the synthetic patient linkage number provided by the HCUP Partner, date of birth, and sex. No verified patient linkage number was assigned if any one of the three pieces of information was missing.

NRD_DaysToEvent, and (LOS) length of stay.

Randomly-assigned start date, NRD_DaysToEvent is used instead of actual admission and discharge dates in order to comply with privacy guidelines, and it is used with the Length of Stay variable to calculate time between admissions.

Time Between Admissions

In order to calculate time between admissions in this study, I used the variables NRD_ Days_ToEvent (fake starting date) and LOS (length of hospitalization) to create new variable called DischargeDate (fake discharge date)

DischargeDate = NRD_ DaysToEvent **+** LOS

Example: to identify readmission stays.

A patient has a 3-day hospital admission on 1/10/2014 and another admission on 1/25/2014.

- Based on the randomly-assigned start date for the NRD_VisitLink, the NRD_DaysToEvent value is 1009 for the 1/10/2014 admission. And the NRD_DaysToEvent value is 1024 for the 1/25/2014 visit.

Discharge date for the first stay will calculated as = 1009 (NRD_DaysToEvent) + 3 (LOS) = 1012.

Determining the number of days between the end of first admission and the start of the second admission will be as below:

Second Stay (NRD_DayToEvent) 1024 – Previous DischargeDate 1012 = 12 days between the two events.

According to our readmission's criteria in this study, an index admission will be counted as a readmission if it happened (NRD_ Days_ToEvent) within 30 days of the initial stay (DischargeDate), other than that it will be count as new index admission.

A dummy variable to identify whether record is considered a readmission will be created.

3.5 Analytical Methods by Research Aims.

3.5.1 Aim 1: Differences in readmission rate based on discharge destinations.

Have there been differences in readmission rate between patients who discharged direct to home without any form of post-acute care and those who received any type of post-acute care, or there been differences in readmission rate between patients who received post-acute care services at home and those who discharged to post-acute care facilities

Hypothesis#1 : Patients who received any form of post-acute care services are less like to be readmitted to a hospital within 30 day of discharge after TJA.

Hypothesis#2 : Patients who received post-acute care services at home are less likely to be readmitted to hospital within 30-day of discharge after TJA.

Patients will be grouped according to their discharge destination into one of three scenarios:

- Home (Direct to home without Home Care Servicers).
- Home with Health Services.
- Inpatient rehabilitation including Skilled Nursing Facility (SNF).

- Descriptive statistics will be performed, and 30-day readmission rates will be compared between discharge dispositions using the Chi-Square test.

3.5.2 Aim 2: Patient, and hospital factors associated with the30-day readmission after TJA.

What patient, and hospital factors are associated with the30-day readmission after TJA, are there any differences in the TJA readmissions rats between payers.

- logistic regression analysis will be performed to evaluate factors associated with 30-day readmission while controlling for age, gender, and severity of illness. Factors investigated will include hospital related, and patient related factors.

$$logit\ (p) = b0 + b1\ X1 + b2\ X2 + b3\ X3$$

where P is the probability of being readmitted, the logit transformation is defined as the logged odds:

$$odds = \frac{p}{1-p} = \frac{probability\ of\ readmission}{probability\ of\ no\ readmission}$$

and

$$logit(p) = \ln\left(\frac{p}{1-p}\right)$$

X1 = Patient Characteristics
X2 = Hospital Characteristics
X3 = Discharge dispositions

Models include hospital characteristics, patient characteristics, and post-hospital care characteristics, to determine whether they influence the results. Age will be analyzed by age groups (under 45 years old, 45-54 years old, 55-64 years old, 65-74 years old, 75-84 years old, and 85 or more years). Age was of particular interest as recent literature suggests that total joint procedures are becoming more commonly used in younger adults than was typical until the end of the 20th century. To consider significant association, P-value must be less than 0.0001.

3.6 Covariates.

As suggested in the introduction section of this study, the variables of interest for predicting TJA readmissions are related to the patient, post-hospital care, and hospital

characteristics. We used the discharge-level files to obtain patient related variables including information on the procedure performed, and the severity level. Hospital-related variables associated with readmission risk have been previously studied by Kurtz, Lau et al (S. M. Kurtz et al., 2016b). Hospital-level file provided by the American Hospital Association (AHA) were used to obtain information on hospital characteristics.

Hospital administrative data have been widely used for examining health care utilization, and patient outcomes. Both require adjustment for patient severity of illness. Researchers can develop their own methods or select one of the severity measurement systems available in the public or private domain. In this study we are utilizing the severity of illness index (APR-DGRs- Severity) as a severity adjustment tool because, it is the most applicable to the HCUP inpatient databases (2018 Agency for Healthcare Research and Quality, 2018). Table 3.2 below provides a summary of All Covariate variables in this study.

Table 3.2 Study Covariates.

Patient-Specific Variables	Post-Hospital Care Variables	Hospital variables
1. Age (AGE) Continuous 2. Sex (FEMALE) Categorical 3. Primary Payer (PAY1) Categorical 5. Severity level (APRDRG-Severity) Categorical	1. Disposition of Patient (DISPUIFORM) Categorical	1. Hospital Ownership (H_CONTTRL) Categorical 2. Bed size of hospital (HOSP_BEDSIZE) Categorical

3.7 Descriptive Statistics.

A total of 1,093,272 TJA admissions in 2014 were identified using (ICD-9-CM) Procedure codes 81.51 Total Hip Arthroplasty for and 81.54 for Total Knee Arthroplasty. The average length of hospital stay for these admissions were 3.16 days. And the median age for TJA patients was 65 years. Pie charts below created using Stata 15.1 illustrate admissions' basic statistic related to the primary payer, discharge destinations, as well as some hospital characteristics where procedures performed.

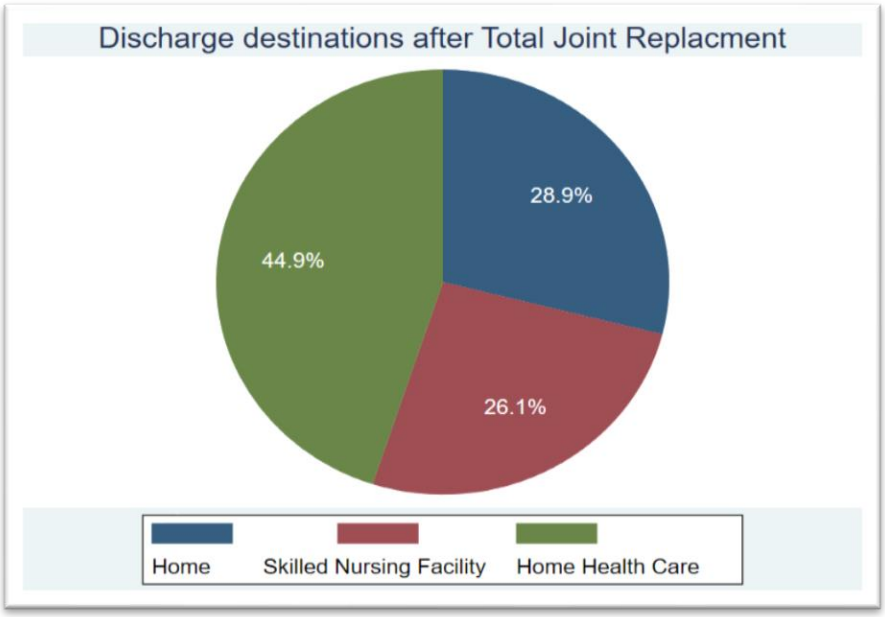


Figure 3.1 Discharge disposition after TJA.

The most common discharge disposition after Total Joint Arthroplasty procedures was to home with home health agency services (44.9%), 26.1% were discharged to Skilled Nursing Facility (SNF), 28.9 % were discharged to home with no farther care (Routine).

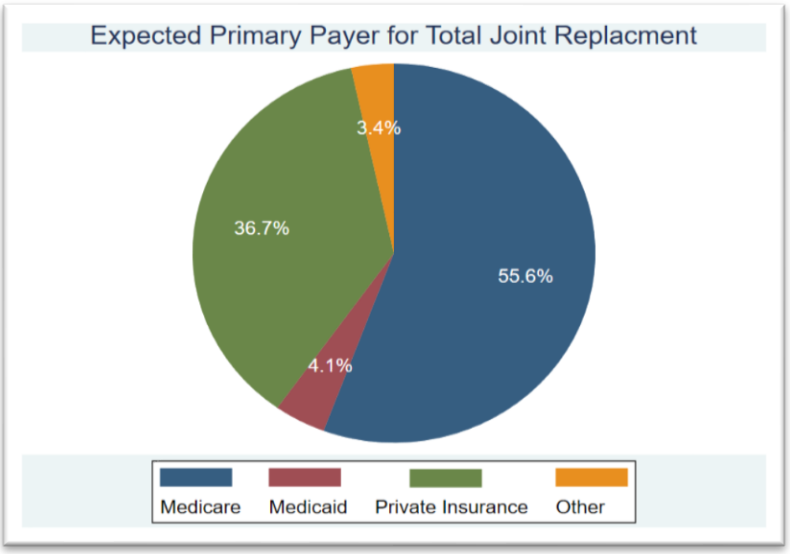


Figure 3.2 Expected Primary Payer for Total Joint Arthroplasty

Fifty-fife (55%) percent of TJA patients have Medicare as their primary insurance, 36.7 % have Private insurance as their primary insurer, and 4.1% have Medicaid, and 3.4 had Other.

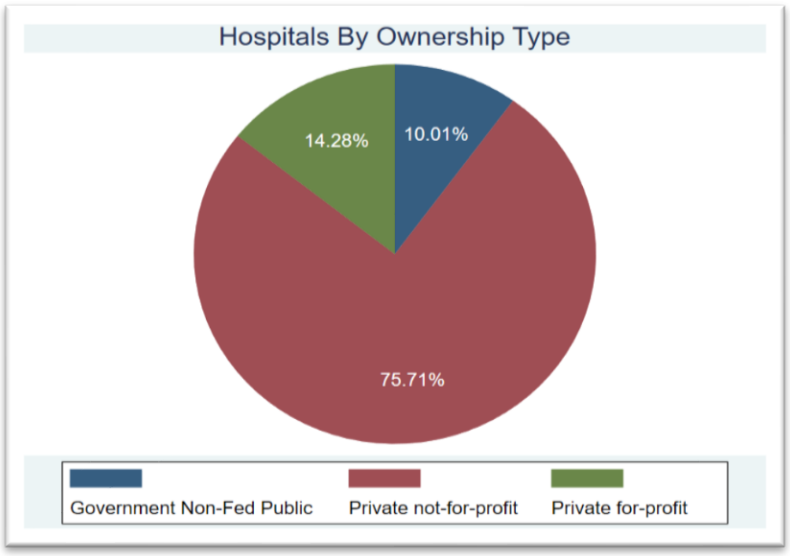


Figure 3.3 Discharges by Hospital Ownership.

75.7% of total discharges where discharged from private not for profit hospitals, 14.3% were discharged from proprietary hospitals, and 10 % where discharges from nonfederal government hospitals.

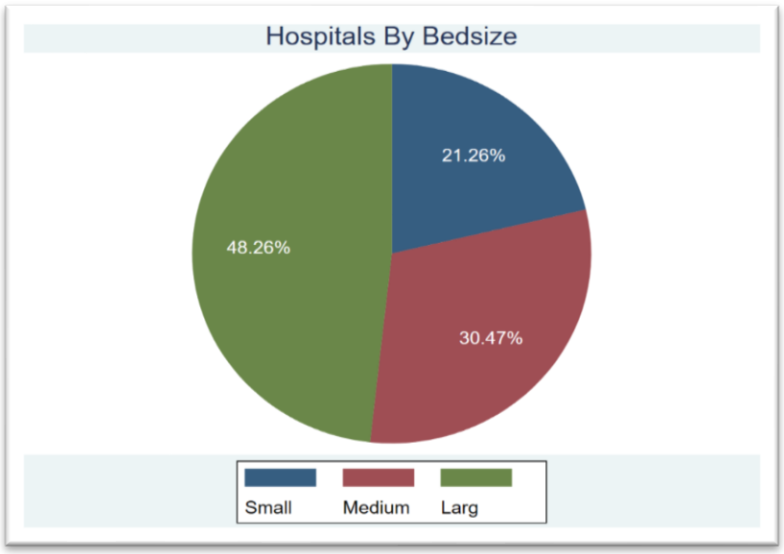


Figure 3.4 Discharges by hospital's Bed Size.

48.3 % of total discharges where discharged from large hospitals, 30.5 % were discharged from medium size hospitals, and 21 % where discharges from small size hospitals.

3.8 Data Management and Quality Assurance.

All users of HCUP data must complete the HCUP Data Use Agreement (DUA) Training Course and sign an HCUP DUA before receipt or use the data. A web-based training course was taken to achieve certification as required by the AHRQ. All procedures used in this study were complaint with the data use agreement including

secure storage and data access as well as privacy protection of data elements including patient identifiable information, or hospitals specific information.

After loading the data according to the HCUP guidelines, data were verified by reviewing the frequency of TJA procedures in 2014 summary statistics reports provided by the data website and comparing it to loaded data results. This process did not reveal any identifiable errors. Manual scanning also was performed on the data, crosschecking readmission information for other conditions, there was no change made to the original data when compare to the summary statistics report files provided by HCUP (2014 Agency for Healthcare Research and Quality, 2018b).

CHAPTER 4

RESULTS

4.1 Characteristics of TJA Discharges.

We analyzed qualifying 935,391 TJA admissions in the United States between January and November of 2014. The national rate of 30-day readmission after primary TJA was 4% (95% confidence interval [CI], 3.9 - 4.1). The mean age for total joint arthroplasty patients was 66 years, and 68 years for those who were readmitted within 30 days of the index admission (Table 5). However, this result may be due to the small variation in age within the vast majority of TJA patients. Among those patients readmitted, 57 % were female, 43 % male. Sixty-seven (67%) percent of the patients readmitted had Medicare as their primary insurance, 5% had Medicaid, 24% had private insurance, and 4% had other types of payments including self-pay and no charges. Thirty-seven (37%) of the those readmitted had minor or no loss of function, 49% had a moderate loss of function , 12% had a major loss of function, and 2% had an extreme loss of function upon admission. The most common discharge disposition of the readmitted was to skilled nursing, and Intermediate care facilities (39%). Thirty-eight (38%) percent were discharged to home with home health-care agency services, and 22% were discharged to home without such services. Approximately half (49%) of the readmitted TJAs were performed in large hospitals, 31% were performed in medium

sized hospitals, and 20% were performed in small hospitals. Three-quarters (75%) of the readmitted TJAs were done in privately owned voluntary hospitals, 14% were performed in a private proprietary hospital, and only 10% of readmitted TJAs occurred in government nonfederal public hospitals.

Table 4.1 Characteristics of TJA Discharges.

Selected patient, clinical, and hospital factors	Primary TJAs	30-day readmission
Total	N= 935,391 (100%)	N = 38,012 (100%)
Mean age years (SD)	66 (10.4)	68 (11.4)
Sex n (% of total)		
Male	371,868 (40%)	16,337 (43%)
Female	561,474 (60%)	21,675 (57%)
Primary Payer n (% of total)		
Medicare	522,153 (56%)	25,246 (67%)
Private Insurance	336,640 (35%)	9,483 (24%)
Medicaid	39,152 (5%)	1,952 (5%)
Other	35,434 (4%)	1,302 (4%)
APR DRG n (% of total)		
Minor	449,761 (49%)	13,943 (37%)
Moderate	436,699 (46%)	19,171 (49%)
Major	48,713 (5.6%)	4,676 (12%)
Extreme	3329 (0.4%)	643 (2%)
Hospital size by bed n (% of total)		
Small	227,331 (21%)	8,866 (20%)
Medium	271,633 (31%)	10,980 (31%)
Large	439,539 (48%)	18,587 (49%)
Hospital type n (% of total)		
Public	89,728 (10 %)	3,837 (10%)
Voluntary	728,935 (73%)	29,082 (75%)
Proprietary	119,840 (16%)	5,515 (14%)
Patient Disposition n (% of total)		
Home	273,135 (29 %)	8,656 (22%)
Skilled Nursing Facility (SNF), or (ICF)	247,038 (27%)	14,857 (39%)
Home Health Care (HHC)	412,984 (45%)	14,494 (38%)

APR DRG = all patient-refined diagnosis-related group severity. (ICF) = Intermediate Care Facility.

4.2 Most Common Diagnosis Associated with TJA.

Consistent with previous studies, the most common diagnosis associated with joint arthroplasty in United States was osteoarthritis. Approximately 94 % of all discharges with TJA had an ICD-9 code for osteoarthritis (Table 4.2) . Other conditions such as joint disorders, deformities, and rheumatoid arthritis were found with very limited frequency during the study period , which is consistent with other published literature on indications of total joint arthroplasty.

Table 4.2 Diagnoses for patients undergoing primary TJA.

Diagnosis	Percentage
Osteoarthritis	94 %
Other bone disease and musculoskeletal deformities	2.2 %
Fracture of neck of femur (hip)	1.3 %
Other non-traumatic joint disorders	0.8 %
Joint disorders and dislocations; trauma-related	0.5 %
Rheumatoid arthritis and related disease	0.4 %

Source: The National Readmission Database, 2014.

4.3 Factors Associated with 30-day hospital readmission.

Logistic regression was used to determine which factors had the greatest effect on readmission. Selected factors for this investigation included patient's age, gender, type of insurance , discharge destination, and DRG severity. All these factors were significantly associated with readmission , at $p < 0.0001$; however, it is important to note

that the study's statistical power is sufficient to detect small differences. Thus, we examined each factor in greater detail by examining the odds ratios and crosstab frequencies.

All patient-refined diagnosis-related group (ARP DRG) severity was added to the model to control for the severity of comorbid illness. Age had a minor effect on readmission, considering the odds ratio of 1.008 (Table 7). Female patients had a 22% lower risk for readmission than the males. Patients who had Medicare as the primary payer had 34% higher risks, and those with Medicaid had a 74 % higher risk , while patients with other types of insurance, such as worker's compensation or other government programs , were at 27% higher risks for readmission when compared to patients with commercial insurance.

Patients' physiological status, which is measured by an APR DRG severity subclass, can have a significant effect on readmissions. Patients with a minor loss of function had a 65% lower risk, and patients with a moderate level had a 52% lower risks, while patients with an extreme loss of function had a 90% higher risk of readmission when compared to patients with a major loss of function.

Discharge disposition on post-hospitalization care can also have a significant effect on readmissions. Patients discharged to a skilled nursing or intermediate care facility were at 61% higher risk for hospital readmission, while those who were discharged to home health care services were at a 10% higher risk for readmission when compared to patients discharged to home with no further medical services.

Table 4.3 Factors associated with TJA readmission.

Covariate	OR (95% CI)	OR Adjusted for Hospital Type (95% CI)	Hospital Type p value
Age in years	**1.008 (1.006 -1.010)***	**1.008 (1.006-1.010)**	< 0.000
Gender:			
Male (reference)	**Ref**		
Female	**0.782 (0.757-0.807)***	**0.782 (0.755-0.804)**	< 0.000
Insurance:			
Private (reference)	**Ref**		
Medicare	**1.340 (1.282-1.400)***	**1.328 (1.270-1.388)**	< 0.000
Medicaid	**1.740 (1.615-1.874)***	**1.728 (1.604-1.861)**	< 0.000
Other	**1.275 (1.169-1.390)***	**1.263 (1.158-1.378)**	< 0.000
(APR DRG) Severity Subclass:			
Major (reference)	**Ref**		
Minor	**0.350 (0.332-0.369)***	**0.347 (0.329-0.365)**	< 0.000
Moderate	**0.480 (0.456-0.505)***	**0.470 (0.454-0.503)**	< 0.000
Extreme	**1.905 (1.667-2.191)***	**1.893 (1.647-2.177)**	< 0.000
Discharged to			
Home (reference)	**Ref**		
(SNF), or (ICF)	**1.614 (1.545-1.686)***	**1.597 (1.528-1.668)**	< 0.000
Home Health care	**1.090 (1.046-1.136)***	**1.081 (1.037-1.126)**	< 0.000
Hospital Size in beds:			
Small (reference)		**Ref**	
Medium		**1.054 (1.008-1.102)**	0.019
Large		**1.060 (1.018-1.106)**	0.005
Hospital Control/ownership:			
Public (reference)		**Ref**	
Voluntary		**0 .920 (0.877-0.972)**	0.002
Proprietary		**1.111 (1.045 -1.183)**	0.001

*Significant at the p<0.0001 level

HCUP National Readmission Database, 2014

SNF = Skilled Nursing Facility, **ICF** = Intermediate Care Facility .

Readmission rates for different settings can be found in (Figure 4.1) . TJA patients discharged to Home or Self Care (Routine Discharge) had the lowest rates of 30-day readmission at 3.13% in 2014. Therefore, we rejected our hypothesis # 1 that patients who received any form of post-acute care services are less like to be readmitted to a hospital within 30 days of discharge after TJA.

Patients discharged to home with health agency services had a 3.52% readmission rate, while patients discharged to a skilled nursing facility or intermediate care facility had the highest 30-day readmission rate at 6.06 %. Therefore, we accepted our hypothesis #2 that patients who received post-acute care services at home are less likely to be readmitted to hospital within 30 days of discharge than those who were discharged to inpatient post-acute care settings.

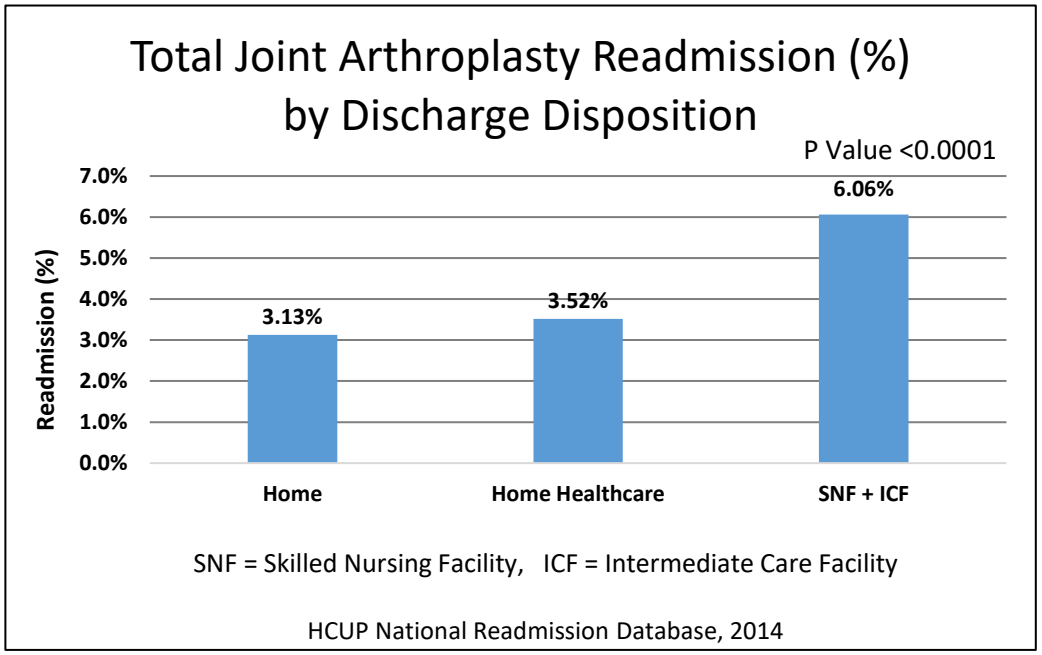


Figure 4.1 Readmission rates by Discharge Disposition.

We predicted that, due to HRRP and the Bundled Payments for Care Improvement (BPCI) initiatives, Medicare patients' 30-day readmission rate would be lower than the rate for those who are commercially insured. However, Medicare patients had the second highest 30-day readmission rate at 4.86% (Figure 4.2) , while privately insured patients had the lowest 30-day readmission rate. Therefore, we rejected our hypothesis.

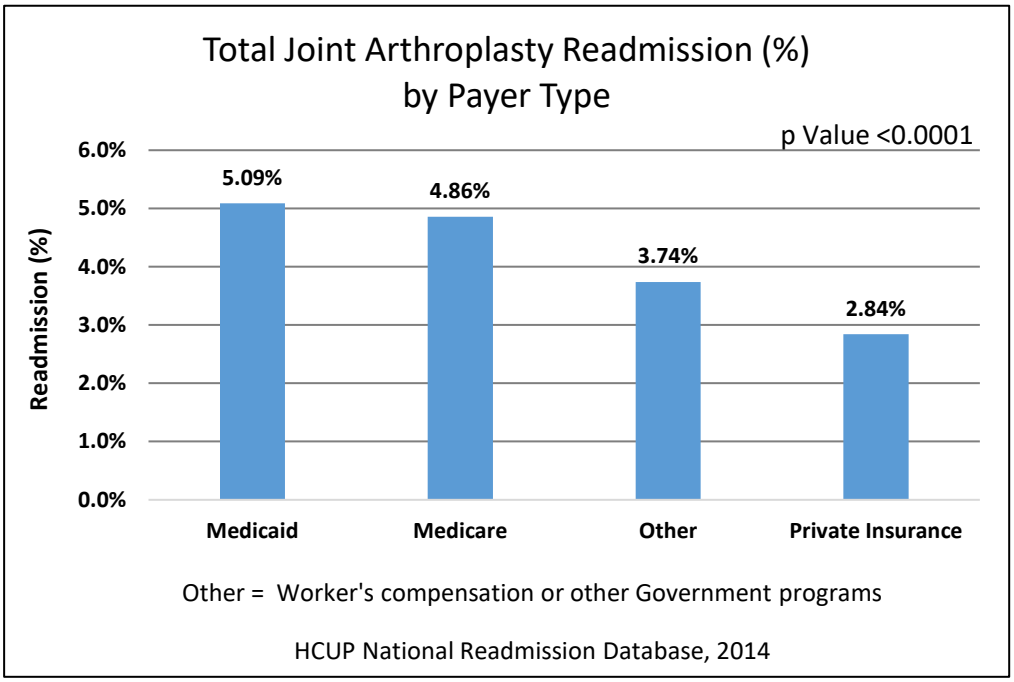


Figure 4.2 Readmission rates by Payer Type.

4.4 Study Limitations.

The study analysis had several limitations. First, we limited the analysis to in-state patients because the NRD data is confined to in-state readmissions, thus events may

have been under-reported. Second, we found that the 30-day readmission rate for the privately insured population is considerably less than the Medicaid and Medicare population (Figure 5), which may be to the fact that patients undergoing TJA who are covered by private insurance tends to be younger and healthier than patients on Medicare or Medicaid. Thus , the lower readmission rate by the privately insured patients tend to drive down the national readmission rates below what had been reported using the Medicare population alone (S. M. Kurtz et al., 2016a, 2016b), which corresponded to 9.6%. However, the national readmission rates for TJA in our study are consistent with the findings of others(V. Avram et al., 2014; Jordan et al., 2012). Also claims-based administrative data have the potential to contain errors associated with a recording diagnosis. However, healthcare cost and utilization project data are rigorously examined to ensure accuracy ,widely used to estimate diagnosis frequency, and utilized for public reporting. Third, because this study focused on index admissions, readmissions, and discharge disposition, other variables such as visits to emergency rooms, urgent care facilities, and outpatient centers, all of which are important in improving care transitions, were not available in the NRD. Fourth, index events were captured from January through November which allow a 30-day window from each hospital admission that could be used to search for readmissions. However, this approach could potentially mark a readmission in the first 30 day of the year as an index event, because data from the last month of the previous year were not available.

CHAPTER 5
CONCLUSION

This national study provides important insights into risk-adjusted TJA national 30-day readmission rates in 2014 and looks closely at readmission risks among post-acute hospital discharge care settings. Discharge disposition can have a significant effect on the 30-day readmission rate. Female patients had a 22% lower risks for readmission than the males. Patients discharged to a skilled nursing or intermediate care facility had a 61% higher risk for hospital readmission, while those who were discharged to home health care services had a 10% higher risk for readmission when compared to patients discharged to home with no further medical services. Patients who had Medicare as the primary payer had a 34% higher risk, and those with Medicaid had a 74 % higher risk, while patients with other types of insurance, such as worker's compensation or other government programs, had 27% higher risks for readmission when compared to patients with commercial insurance.

Our study has three key findings. First, TJA patients discharged to home tend to have the lowest rates of 30-day readmission. Second, patients who receive post-acute care services at home are less likely to be readmitted to the hospital as compared with those who received post-acute care at inpatient settings such as skilled nursing or intermediate care facilities. Third, our study shows the shortcomings of the HRRP and

Bundled Payments Models in the readmission rate and penalty formulas that can misrepresent health provider performance. Metrics used in the HRRP in rewarding and penalizing hospitals have a profound effect not just on what providers do, but also on what they choose to avoid doing. Refinements such as expanding the quality metrices used in HRRP to include post-acute care settings may better align program incentives between both types of providers (i.e., hospital and post-acute care providers) improve the HRRP and patients' overall outcome of care through policy changes. Bundled payment has become a popular concept since introduced in the Patient Protection and Affordable Care Act of 2010, and the strategy has shown promise in reducing spending in some medical conditions. However, the implementation of a new payment method is complicated and healthcare providers are not universally enthusiastic to adopted. Hospitals, post-acute care providers, and patients can each influence readmission rates, and some readmission may be avoided through better planning to an adequate discharge destination and smoother transitions of care with the ultimate goal of improving both the efficiency of care delivery and patient experience of care. It would be better for post-acute care providers and hospitals to become better aligned and incentivized to work together to improve care coordination. Also, by understanding factors that are associated with readmission, health policy can be further improved to avoid misaligned regulation and implement incentives to encourage better collaboration among all providers, thereby boosting the adoption of evidenced-based clinical interventions to improve care and avoid common, costly unplanned readmissions.

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APPENDIX A

OVERVIEW OF KEY READMISSION MEASURES USED BY AHRQ

Table A.1 AHRQ Healthcare Cost and Utilization Project 30-Day Readmissions.

General Information	
Primary Purpose	Public reporting of the national burden of 30-day readmissions. The AHRQ-sponsored Web site HCUPnet (http://hcupnet.ahrq.gov) provides online access to the national readmission statistics.
Measure Title	30-day same- and all-cause national readmission rates
Readmission Rate	This measure is used to calculate national estimates of the percentage of hospital admissions that had at least one readmission within 30 days.
Target Population	Adult Patients who were admitted in a calendar year. (2014)
Data Source	HCUP readmission analysis file using the HCUP State Inpatient Databases (statewide hospital administrative data) weighted to calculate national estimates of inpatient readmissions.
Hospitals Included	Community, nonrehabilitation, nonspecialty hospitals.

Risk Adjustment	Primary diagnosis and severity of illness were risk adjusted using the four levels of severity of illness (APR-DRGs) Severity of Illness. APR-DRGs were developed to reflect the clinical complexity of the patient population. Readmission rates were stratified by age, sex, expected payer, community income quartile, and metropolitan location.
Reference	A detailed description of the methodology for the HCUP 30-day readmission rates are available at http://hcupnet.ahrq.gov/HCUPnet.app/Methods-HCUPnet%20readmissions.pdf?JS=Y
Definition of Index Admission (Denominator for Rate)	
Qualifying Event	Discharged alive with a condition of interest (see clinical scope).
Clinical Scope	Index admissions are identified by major diagnostic category (MDC), diagnosis-related group (DRG), and AHRQ Clinical Classification Software (CCS) for principal diagnoses and all-listed procedures. All Patient Refined Diagnosis Related Groups (APR-DRGs) Version 32.0 codes, (301 P 08 Hip Joint Replacement, and 302 P 08 Knee Joint Replacement) was used to defined index admission in this Study.
Other Considerations	Transfers identified by one inpatient stay that ends on the same day as a second inpatient stay begins are allowed as an index admission, but they are only counted once. The information reported on the two discharges records related to the transfer is combined into a single inpatient event. The combined inpatient record is allowed to be an index admission. A patient is allowed to have multiple index admissions, regardless of how far apart they occur. In addition, a readmission can also count as an index stays for a subsequent readmission.

	Patients discharged in December are excluded, because the HCUP databases are calendar-year files and December discharges could not be followed for 30 days.
Definition of Readmission (Numerator for Rate)	
Qualifying Event	First admission that occurs within 30 days of an index admission with a condition of interest.
Limited to Readmission at the Same Hospital?	No, but limited to a readmission to a hospital in the same State.
Clinical Scope	Principal diagnoses are Total Knee/Hip Arthroplasty. (ICD-9-CM) procedure codes 81.51 and 81.54 used to identify condition of interest (index events). While readmission reasons can by any thing that makes patient to come back to the hospital within 30-days of the initial admission. Readmission rates reported on HCUPnet consider readmissions for the same condition and all causes. • For rates by MDC and DRG, readmissions for the same MDC or DRG and for all causes are considered. • For rates by principal diagnosis grouped by CCS, readmissions are considered for the same principal diagnosis CCS, for the same diagnosis CCS as a principal or secondary, and for all causes. • For reporting by procedure grouped by CCS, readmissions for all causes are considered.

APPENDIX B

HCUP STATES PARTICIPATING IN THE 2014 NRD

Table B.1 HCUP Partners Participating in the 2014 NRD.

State	HCUP Data Source
1. Arkansas	Arkansas Department of Health
2. California	California Office of Statewide Health Planning and Development
3. Florida	Florida Agency for Health Care Administration
4. Georgia	Georgia Hospital Association
5. Hawaii	Hawaii Health Information Corporation
6. Iowa	Iowa Hospital Association
7. Louisiana	Louisiana Department of Health and Hospitals
8. Massachusetts	Massachusetts Center for Health Information and Analysis
9. Maryland	Maryland Health Services Cost Review Commission
10. Missouri	Missouri Hospital Industry Data Institute
11. Nebraska	Nebraska Hospital Association
12. New Mexico	New Mexico Department of Health
13. Nevada	Nevada Department of Health and Human Services
14. New York	New York State Department of Health
15. South Carolina	South Carolina Revenue and Fiscal Affairs Office
16. South Dakota	South Dakota Association of Healthcare Organizations
17. Tennessee	Tennessee Hospital Association
18. Utah	Utah Department of Health
19. Virginia	Virginia Health Information
20. Vermont	Vermont Association of Hospitals and Health Systems
21. Washington	Washington State Department of Health
22. Wisconsin	Wisconsin Department of Health Services

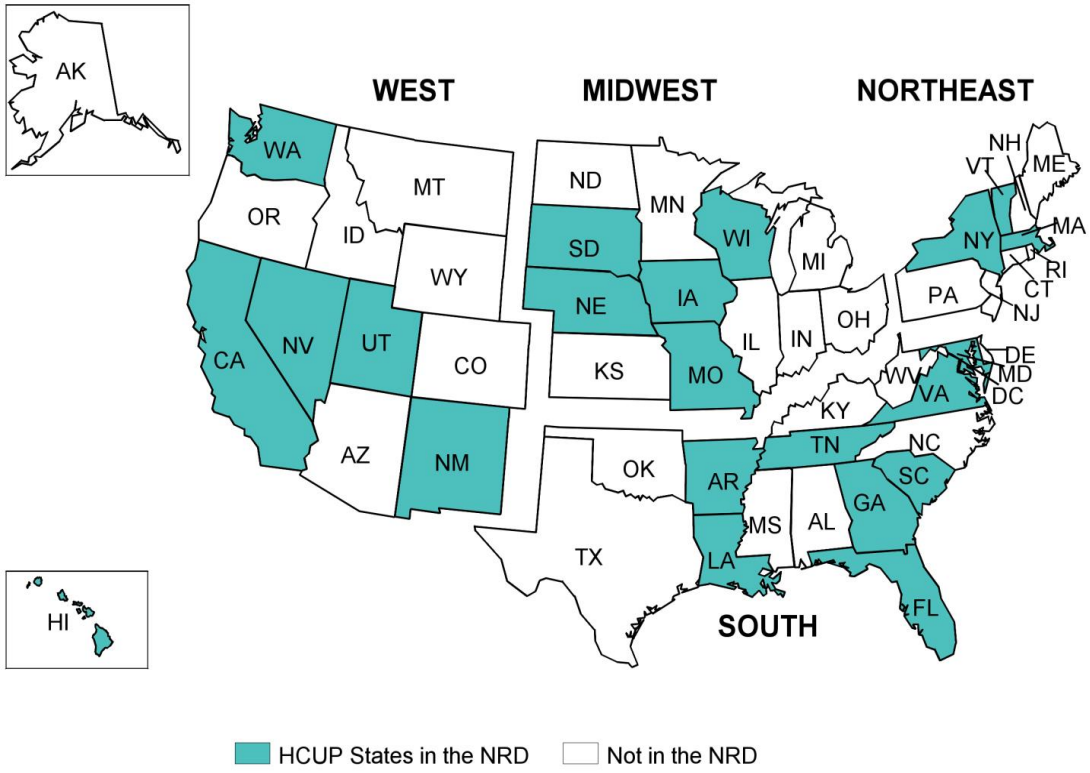

Figure B.1 HCUP States Participating in the 2014 NRD.

Table B.2 Percentage of SID Discharges in the NRD by Type of Discharge.

Type of Discharge	Percentage of SID Discharges, 2014
Included in the NRD	85.0
Excluded from the NRD	15.0
Hospital-level exclusions	
Noncommunity hospitals	2.7
Rehabilitation or LTAC hospitals	0.2
Discharge-level exclusions	
Discharges from patients with an age of 0 (from 10 of 22 SID)	7.2
Discharges with missing or unverified patient linkage numbers	4.1
Questionable patient linkage numbers: same patient linkage number on 20 or more discharges	0.2
Questionable patient linkage numbers: patient is hospitalized after discharged dead	0.02
Questionable patient linkage numbers: overlapping inpatient stays	0.4
Discharges from hospitals with more than 50 percent of their total discharges excluded for any of the above causes	0.2

Table B.3 Summary of NRD States, Hospitals, and Inpatient Stays.

Year	States	Number of States for Discharges Aged 1 and Older	Number of States for Discharges Aged 0	Number of Hospitals	Number of Discharges in the NRD, Unweighted	Number of Discharges in the NRD, Weighted
2014	AR, CA, FL, GA, HI, IA, LA, MA, MD, MO, NE, NM, NV, NY, SC, SD, TN, UT, VA, VT, WA, WI	22	12	2,048	14,894,613	35,306,427

APPENDIX C

INTERVENTIONS TO REDUCE 30-DAY READMISSION RATE

Table C.1 Interventions to reduce 30-day readmission rate.

Interventions to reduce 30-day readmission rate
Comprehensive program including four activities: 1. Outpatient workup of venous thromboembolism. 2. Decrease surgical site infection. 3. Early follow-up with primary care physicians. 4. Increase physician awareness of the financial and quality-related ramifications of unplanned readmission. (Jordan et al., 2012)
Clinical Pathways for improving patient outcomes after knee arthroplasty (Pearson, Moraw, & Maddern, 2000)
Evidence-based protocols and increasing care management services. 30-day all-cause readmission rate decreased from 7% to 5%. (Dundon et al., 2016)
Military Health System three initiatives: 1. Communication, education, and improvement strategies. 2. Evidence-based practices. 3. Planning and Design. 11% reduction in 30-day hospital readmission was achieved by the MHS.(King et al., 2017)